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RUN REPORTS: CO_2 ACCEPTOR PROCESS GASIFICATION PILOT PLANT

Final Report, Volume 8, Book 2 of 6, Runs 12–18, August 1973–April 1974

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RUN REPORTS

CO_2 ACCEPTOR PROCESS GASIFICATION PILOT PLANT

FINAL REPORT, VOLUME 8
BOOK 2 OF 6, RUNS 12 - 18
PERIOD: AUGUST 1973 - APRIL 1974

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FOREWORD

The reports contained in this document were prepared jointly by Conoco Coal Development Company and Stearns-Roger, Incorporated, as partial fulfillment of the Department of Energy contract (EX-76-C-01-1734) for the development of CO_2 Acceptor Gasification Process. Each report normally covers the operation of the CO_2 Acceptor Process Pilot Plant for a single run. Some runs, however, have several parts (A, B, C, etc.) and occasionally two or more runs have been grouped together in a single report.

The reports are informal data reports which were written shortly after the completion of the respective runs. The reports serve the purpose of recording the objectives, accomplishments, and problems encountered during the pilot plant operations. Operating data are also often presented. However, these data are, for the most part, presented as a matter of record since the inclusion of heat and material balances and the analysis of the data was not part of the scope of the run reports.

Prior to Run 16, no periods of truly steady-state integrated plant operation were obtained for which heat and material balances can be calculated. The development of a reliable, standardized startup procedure, the solving of process and especially mechanical equipment problems, were the primary concerns during these early runs.

Much needed process data at steady-state conditions were gathered during the later runs. Detailed heat and material balances for selected runs are presented in Volume 12 of the Final Report. Some discrepancies will be found between the data presented in the run reports and the heat and material balance results. For example, the acceptor circulation and gasifier vent rate presented in many of the run reports do not agree with the heat and material balance values.

The run report acceptor circulation rates are based upon the acceptor lift line pressure drop and are considered to be only an approximation of the actual acceptor circulation rate. The pressure drop derived circulation rate served as a guide to the plant operators and provided trend information. Because of the severe temperature and pressure conditions in the process, the acceptor circulation and also the fuel char rates cannot be directly measured. These rates can only be accurately determined via detailed heat and material balance calculations. A mathematical model of the process, which is embodied in the form of a computer program was therefore developed. The model values for the acceptor circulation and the fuel char rates are presented in the detailed heat and material balances. These rates are considered to be correct.

The measured gasifier vent rates (product gas rates) contained in the run reports are generally lower, and often much lower, than the mathematical model values. There are several reasons for this. First, process flow measuring instrumentation was often fouled by the small amounts of char fines and liquid water contained in the vent gases. Secondly, undetected process leaks from valve packings and from vessel and piping flanges represent sizable losses in the available vent gas quantity to be measured. The actual vent gas from the gasifier is better represented by the mathematical model value than by the measured value.

The above examples point out that consideration must be given and judgements made concerning the use of certain process data. The philosophy with respect to data analysis, has been to use the mathematical model to match as much as possible the measured process data. Differences between the model results and the measured data are resolved by the reexamination of instrument records and the pilot plant logs or by modifying the model where necessary.

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RUN 12

AUGUST 2 TO SEPTEMBER 19, 1973

CO_2 ACCEPTOR PROCESS GASIFICATION

PILOT PLANT

RAPID CITY, SOUTH DAKOTA

1 SUMMARY

Runs 12A, 12B, 12C, and 12D were conducted during August and September of 1973 and constituted the Run 12 series. The initial objective of these runs was to obtain a balance period in which heat losses from the gasifier and the regenerator could be measured. This was to be accomplished by batch calcining the regenerator bed and then lining out the reactor temperatures without circulating acceptor while maintaining steady state conditions. After gathering pertinent data, fully integrated plant operation was to be attempted with the resumption of acceptor circulation.

Steady state conditions were never achieved during Run 12A because a transformer in the motor control center failed. This caused the recycle gas compressors to shut down and resulted in the defluidization of both the regenerator and gasifier beds. When the compressors were back in service, the regenerator bed and the gasifier char bed were refluidized. However, since acceptor had filled the gasifier boot inlet gas line, the acceptor in the boot could not be fluidized and the plant was shut down.

A four hour steady state balance period was successfully achieved during Run 12B. Afterwards, acceptor circulation was initiated and maintained for 45 minutes. Then circulation ceased when the calcined acceptor standleg plugged. The line could not be cleared so the plant was shut down.

After a preliminary work up of the heat balance data taken in Run 12B, the data was transmitted to Consol's research center in Library, Pennsylvania, for further study. Table 12-22, page 59, shows heat and material balance data for Run 12B. Present plans are to issue a report covering the balance period at a later date. Despite the presence of severe regenerator deposits, the data represent plant operation without acceptor circulation and are as complete as possible with current sampling equipment and procedures. Therefore, no further effort was made during Runs 12C and 12D to obtain heat loss data. In these runs, acceptor circulation began immediately after the completion of batch calcination. The shutdowns for these runs resulted from: (1) inability to establish acceptor circulation following calcination for Run 12C; and (2) plugging of the calcined acceptor standleg after circulation was established during Run 12D.

Aside from Run 12A which was terminated by an electrical failure, each of the Run 12 series resulted in regenerator deposits. In Run 12B these deposits took the form of a massive wall accumulation. Runs 12C and 12D deposits were primarily spherical or ball shaped agglomerations of acceptor and char ash fines. The largest spheres were formed during Run 12C. Many of these measured 1 to 1-1/2 inches in diameter.

A review of the run conditions and analytical results suggested two new possible mechanisms for formation of the "balls" and the deposits. These are sintering of fines as a result of localized undetected hot spots and transient liquid caused by the presence of $CaS.CaSO_4$ mixtures in the incoming acceptor.

None of the runs was characterized by low regenerator CO concentrations or O_2 breakthrough, the known cause for regenerator deposits. In both runs, many hours of char combustion occurred with regenerator bed temperatures of about 1800°F. Often CO concentrations in excess of 5 mol percent occurred without the heat sink provided by circulating acceptor. During bench scale work, high CO levels always resulted in high temperatures in the bottom of the regenerator. Throughout Run 12, the amount of regenerator deposit was proportional to the time of char combustion without acceptor circulation. Additional evidence of undetected bottom hot spots was obtained following Run 12D. Many of the regenerator air distributor ring bubble caps had been melted.

Chemical analyses of the acceptor leaving the gasifier to Run 12D showed the existence of Both CaS and $CaSO_4$. If the original sample contained only sulfide sulfur, two possible sources of the sulfate are: (1) analytical measuring errors; and (2) sulfide oxidation of a hot sample exposed to air. However, assuming that the sample actually contained a sulfide sulfate mixture, transient liquid could occur at any regenerator condition. CaS formed while the acceptor showered through the gasifier char bed could have been oxidized as it passed the air-steam distributor ring in the gasifier transition zone. The 600°F boot temperature was sufficiently cool that reduction of the $CaSO_4$ did not occur. Removal of the temperature limitation on the gasifier boot heater would help prevent the existence of $CaSO_4$ in three ways: First, the amount of air required to maintain the gasifier bed temperature would be minimized; second, the boot temperature would be higher, increasing the reaction rate for reduction of $CaSO_4$; and, third, the H_2 content of the recycle gas would be increased as the steam/air increased.

Plugging of the calcined acceptor standleg was the major problem encountered during the Run 12 test series and was common to all runs. Depending upon the run, the line plugs were either mechanical or chemical in nature or a combination of the two. Runs 12A and 12C plugs were caused by back-flushing of gasifier steam up the standleg prior to circulation. The steam condensed in the cold standleg forming a plug. This type of plug can be easily avoided by properly adjusting the pressure differential between the two reactors.

The Run 12B plug was apparently mechanical in nature but may have been chemical as well, due to the general tackiness of the fines which adhered to the acceptor. This block appeared to be caused by bridging of fines and coarse acceptor. Fines segregation due to line purge may have promoted plug formation. Elimination of this type of plug may depend upon: (1) adjusting the differential between the regenerator and gasifier reactors to reduce the amount of line purge; and (2) reducing the amount of fine material carried into the standleg. Adjustment of both the regenerator free board and the fluidizing gas velocity may be necessary. This is especially important following the initial acceptor calcination when the acceptor is softest and the fines generation is greatest.

Run 12D line plug was caused by the breaking away of an internal pipe scale which then restricted and blocked further solids flow through the line.

The pipe wall deposit consisted of agglomerated acceptor fines. Sticky acceptor fines can be formed in three ways: (1) transient liquid ($CaSO_4$.CaS at 1700°F or above); (2) tacky fines due to high temperature at the bottom of the regenerator; and (3) $CaCO_3$.$Ca(OH)_2$ mixture in the temperature range of 1200° to 1300°F caused by steam backflushing. Since the regenerator bed level was low at the time the return line plugged, any one of the three mechanisms was possible.

The objective for Run 13 is to obtain steady state integrated plant operation. The major process startup changes are (1) to continually circulate acceptor during and after calcination and (2) to immediately cool the regenerator below 1600°F should acceptor circulation be lost. These two changes should reduce the chances for deposit formation in the regenerator.

2 TEST DATA

Run 12 data are presented graphically and/or tabularly at the end of this run report. These figures and tables include:

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3 ACCEPTOR GRINDING - 100 AREA

An objective of Run 12 was to change out the original 6 X 16 mesh acceptor used during the startup to a 6 X 9 mesh acceptor. The 6 X 16 acceptor must be used during the startup because there is not enough recycle gas to fluidize the larger acceptor until the bulk acceptor bed is calcined. Fluidization is easier once the acceptor is calcined since the particle density is less and gas velocities are higher due to increased bed temperature. After the regenerator bed is calcined, 6 X 9 acceptor may then be used to change out the 6 X 16 material. The 6 X 9 acceptor will shower better through the char bed improving the plant operation.

Prior to Run 12, acceptor grinding had not been a problem because the yield of 6 X 16 was about 45 percent, and the rate of production was more than enough to meet the plant's needs. When grinding 6 X 9 during Run 12B, however, the rate of production was slow enough that consumption exceeded production. Also, the yield of 6 X 9 product was only about 10 percent. One of the reasons for the low yield and production rate was that the hammer mill was designed to produce 90 percent of -8 mesh material. A test program was run after the original 1/4-inch grating in the hammer mill was replaced with a 1-inch grating. While the change in the hammer mill increased the rate of production and yield, the results were not very encouraging. The hammer mill was modified again by removing three of the nine hammers. Again this change seemed to help little, if at all.

Rough material balances from the first set of data indicated that the problem in acceptor grinding was the screening operation, not the grinding itself. The screens recycle "oversize" back to the hammer mill. The material balances indicated that three to nine times as much 6 X 9 product was being recycled as was being received as product off the screen. The screen was modified by putting a skirt at the inlet to the screen. This improved the product recovery and another skirt was added about one-third the way down the screen. Material balances after this change show that the product being recycled was reduced to about one-half of the product to the screen. To increase the capacity of the hammer mill, the hammers that had been removed were reinstalled. A third skirt has been added to the screen, but no data has been collected since this was done.

Presently, acceptor grinding yields about 65 percent of 6 X 16 and 35 percent of 6 X 9. The rate of production is now high enough to meet plant feed requirement. Any additional improvements would probably involve major modifications to the screens and hammer mill and cannot be justified. The data from the test run on acceptor grinding is included in Table 12-1. Table 12-2 shows some of the material balances.

4 CHRONOLOGY OF OPERATIONS

4.1 RUN 12A

HOURS FROM CHAR FEED TO REGENERATOR	DATE	TIME	ACTIVITY
(-) 92	8/2	1600	Pressure test complete
(-) 91	"	1700	Regenerator heaters lit
(-) 87-1/2	"	2030	Gasifier heaters lit
(-) 80	8/3	0400	HPC system on
(-) 71	"	1300	Acceptor to gasifier
(-) 66-1/2	"	1730	Acceptor to regenerator from F-206
(-) 61	"	2300	Bridge in gasifier boot
(-) 50-1/2	8/4	0930	Transfer dolomite from gasifier to regenerator
(-) 49-1/2	"	1030	Start acceptor circulation test
(-) 46-1/2	"	1330	End acceptor circulation test
(-) 44-1/4	"	1545	Dumped 125 lbs. to F-213
(-) 43-1/2	"	1630	Added 6 X 9 acceptor to gasifier
(-) 41	"	1900	Air to regenerator
(-) 38	"	2200	Started cooling B-201 A to 600^{o}F
(-) 33	8/5	0300	Unable to fluidize 6 X 9 acceptor--dumped to F-213
(-) 32-1/2	"	0330	6 X 16 added to gasifier
(-) 27-1/2	"	0830	Circulation
(-) 24-1/2	"	1130	Lost char feed to gasifier
(-) 22	"	1400	Recovered char feed to gasifier
(-) 11-1/2	8/6	0030	Circulation test for 5 minutes
(-) 9-1/4	"	0245	Air to gasifier
(-) 8-3/4	"	0315	Char bed level established
(-) 6-1/2	"	0530	6 X 9 makeup to regenerator started
(-) 1	"	1100	Methane in regenerator for 10 minutes
0	"	1200/(1215)	Char started to regenerator--erratically
(+) 1-1/2	"	1330	Char feed to regenerator stabilized
(+) 3	"	1500	Lost char to regenerator momentarily
(+) 4-1/4	"	1615	Calcination started
(+) 16-1/2	8/7	0430	Calcination finished
(+) 28	"	1600	Lost power
(+) 29	"	1700	Boot distributor plugged
(+) 29-1/2	"	1730	Started shutdown

4.2 RUN 12B

HOURS FROM CHAR FEED TO REGENERATOR	DATE	TIME	ACTIVITY
(-) 77	8/17	1400	Pressured up
(-) 74	"	1700	Heater lit
(-) 68-1/4	"	2245	Balance gas purge to LCV-2003 plugged--broke drill bit trying to clear line
(-) 67-1/2	"	2330	Started cooling down
(-) 63-1/2	8/18	0330	Depressured
(-) 59-1/2	"	0730	Repairs completed--started pressuring
(-) 58-1/4	"	0845	Pressured up
(-) 57	"	1000	High ΔP in gasifier tee
(-) 55-3/4	"	1115	Depressured
(-) 55	"	1200	Pressured up
(-) 53	"	1400	Heaters lit
(-) 48	"	1900	HPC system on
(-) 47	"	2000	Hot tube in B-201-IA--started air and steam--attempting to clear tube
(-) 41	8/19	0200	Air and steam out of B-201-IA--tube still plugged
(-) 40	"	0300	Started acceptor to gasifier
(-) 38-1/2	"	0430	Acceptor from gasifier to regenerator
(-) 35	"	0800	Acceptor feed from F-206
(-) 23	"	2000	Started acceptor circulation tests
(-) 20-1/4	"	2245	Started cooling heaters
(-) 18-3/4	8/20	0015	Finished acceptor circulation tests
(-) 18-1/2	"	0030	Air to regenerator
(-) 17-1/4	"	0145	Char started to gasifier
(-) 9-3/4	"	0915	Air to gasifier
(-) 4	"	1500	Acceptor circulation for 1 minute
(-) 3-1/2	"	1530	Acceptor circulation for 1 minute
(-) 3-1/4	"	1545	CH_4 to regenerator
0	"	1900	Char to regenerator
(+) 4-1/2	"	2330	Calcination finished
(+) 6-1/4	8/21	0115	HPC system out
(+) 11-1/4	"	0615	140 LBS 6 X 16 acceptor to gasifier
(+) 15	"	1000	210 LBS 6 X 16 acceptor to gasifier
(+) 22	"	1700	Rapid CO drop in regenerator--CH_4 added and air cut
(+) 24-1/4	"	1915	340 LBS 6 X 16 acceptor to gasifier
(+) 40	8/22	1100	Pressure upset
(+) 41-1/2	"	1230	Acceptor feeder L-204 out
(+) 44-1/4	"	1515	Acceptor feeder back on
(+) 51-1/4	"	2215	350 LBS 6 X 16 acceptor to gasifier

HOURS FROM CHAR FEED TO REGENERATOR	DATE	TIME	ACTIVITY
(+) 56-3/4	8/23	0345	Acceptor makeup off
(+) 61	"	0800	Acceptor makeup back on
(+) 65	"	1200	Circulation started
(+) 65-3/4	"	1245	Circulation lost
(+) 68	"	1500	Char transfer to regenerator lost--plugged line
(+) 69	"	1600	Shutdown started

4.3 RUN 12C

HOURS FROM CHAR FEED TO REGENERATOR	DATE	TIME	ACTIVITY
(-) 98	8/31	1700	Pressured up
(-) 98-1/2	"	1730	Heaters lit
(-) 81-1/2	9/1	0930	Acceptor to gasifier
(-) 81	"	1000	HPC system on
(-) 79-1/2	"	1130	Acceptor from gasifier to regenerator
(-) 75-1/2	"	1530	Acceptor from F-206
(-) 66	9/2	0100	Boot level control problems
(-) 62	"	0500	Boot level control problems apparently solved
(-) 58-1/2	"	0830	Acceptor to regenerator stopped
(-) 57	"	1000	Transfer from boot to F-213 and regenerator not going well
(-) 54	"	1300	Flow juggling--plugged taps
(-) 53-1/2	"	1330	Transfer to F-213 and regenerator
(-) 50-1/2	"	1630	Transfer to regenerator
(-) 50-1/4	"	1645	Acceptor circulation test started
(-) 48-3/4	"	1815	Acceptor circulation test finished
(-) 47	"	2000	Char feed to gasifier
(-) 46	"	2100	Plugged probe dP's switch to side taps
(-) 42-3/4	9/3	0015	Transfer acceptor to regenerator
(-) 42-1/4	"	0045	Stopped char to gasifier
(-) 40-3/4	"	0215	Char feed to gasifier
(-) 37	"	0600	Air to gasifier
(-) 25-1/2	"	1730	Stopped char to gasifier
(-) 17	9/4	0200	ΔP across tee dropped off
(-) 8-1/2	"	1030	Transfer to F-213
(-) 7-3/4	"	1115	Started to cool heater off
(-) 5-1/2	"	1330	Air and CH_4 to regenerator
0	"	1900/(1830)	Char to regenerator
(+) 3	"	2200	Calcination finished
(+) 3-1/2	"	2230	Attempted circulation
(+) 4-1/2	"	2330	Acceptor makeup
(+) 7	9/5	0200	350 LBS acceptor to gasifier
(+) 13	"	0800	More dP's plugged
(+) 16	"	1100	Lost char feed to regenerator
(+) 17	"	1200	Plugged acceptor lift line
(+) 20-1/2	"	1530	Started shutdown
(+) 23	"	1800	Looked better--started back up
(+) 28	"	2300	Started shutdown

4.4 RUN 12D

HOURS FROM CHAR FEED TO REGENERATOR	DATE	TIME	ACTIVITY
			Pressured up Heaters lit
(-) 90	9/14	1500	Acceptor to gasifier
(-) 88-1/2	"	1630	HPC system on--also high ΔP at tee
(-) 87-1/2	"	1730	Acceptor to regenerator and F-213
(-) 87	"	1800	Shutdown started
(-) 84	"	2100	HPC system off
(-) 83-1/4	"	2145	Power failure
(-) 81-1/4	"	2345	Power restored
(-) 80	9/15	0100	Started pressuring up
(-) 78-1/2	"	0230	Pressured up. ΔP at tee--OK
(-) 77	"	0400	HPC system on
(-) 74	"	0700	ESD shutdown by itself
(-) 69	"	1200	Heaters lit
(-) 56-1/4	9/16	0045	Acceptor to gasifier
(-) 54-1/4	"	0245	Acceptor to regenerator from gasifier
(-) 51	"	0600	Acceptor to regenerator from F-206
(-) 34-3/4	"	2215	Trouble starting circulation tests
(-) 33-1/2	"	2330	Started circulation tests--TCV-2003 stuck open
(-) 29-3/4	9/17	0315	Finished Circulation tests
(-) 29	"	0400	Trouble with plugged lignite lock-hopper--char feed to gasifier
(-) 22-1/2	"	1030	Acceptor circulation for 1 minute
(-) 19	"	1400	Air to gasifier
(-) 12	"	2100	High ΔP at tee
(-) 5-1/2	9/18	0330	ΔP at tee lowered
(-) 1-1/2	"	0730	Air and CH_4 to regenerator
0	"	0900	Char to regenerator--char feed erratic
(+) 2-1/2	"	1130	Char feed stabilized
(+) 10-1/2	"	1930	Started acceptor circulation
(+) 11	"	2000	Lost interface
(+) 11-3/4	"	2045	Regained interface
(+) 14-1/2	"	2330	Lost circulation
(+) 15	9/19	0000	Sporadic circulation
(+) 19	"	0400	No circulation
(+) 22	"	0700	Lost char feed--regained
(+) 35	"	2000	Started shutdown

5 PROCESS - 200 AREA

5.1 GENERAL

All startup attempts for the Run 12 series proceeded through the acceptor calcination stage. This is shown in Figures 12-1 through 12-4. These figures cover the period from char combustion until shutdown.

The erratic shape of the Run 12D calcination curve and bed temperature profile, Figures 12-4 and 12-8 respectively, resulted from discontinuous fuel char feed. The reason for char feed loss was not determined but was probably due to either a partial restriction in char standleg, CO-202, or too much line purge to CO-202.

System conditions before and after calcination are shown in Tables 12-3 through 12-6. When differential pressures indicated a bed density gradient, the range is recorded. Density gradients were prevalent in the regenerator bed during the initial calcination period. The density gradients probably resulted from carbon dioxide concentration and temperature differences between the bottom and top of the bed. Therefore, the acceptor at the bottom of the bed would tend to calcine faster than that in the upper section of the bed due to the lower CO_2 partial pressure and slightly higher temperature.

Except for Run 12A, which terminated because of a transformer failure in the motor control center, all shutdowns resulted from the loss of acceptor circulation through the calcined acceptor standleg, CD-206. Additionally, for Run 12C the acceptor lift line, CD-208, plugged after CD-206 was blocked. The simultaneous plugging of all regenerator bed differential pressure probes just prior to the line loss and the excessive amount of sticky fines in the regenerator dump (10.6-26.9 weight percent -28 mesh) indicate that the lift line blockage resulted from regenerator bed bridging.

A study was made to determine if certain size fractions of the regenerator overhead solids preferentially contained acceptor fines. The results of this study are shown in Table 12-18. Based upon the sodium contents, the data show that the acceptor is concentrated in the +48 and -325 size fractions. The intermediate fractions are mainly char ash.

A similar analysis of the raw feed char shows that the -100 mesh char is high in iron and silica. Since the ash composition of the gasifier overhead solids is nearly identical to that of the -100 mesh raw feed char (see Tables 12-8, 12-13, 12-14, and 12-15), the data indicate that the feed char fines are rapidly stripped. Therefore, depending upon the amount of fines in the feed, these fines can represent a considerable heat load on the system.

5.2 BALANCE PERIOD

With the exception of Run 10B, Run 12B was the only other run in which significant heat and material balance data were obtained. During this run the plant was lined out and operated over a four-hour period (August 22, 1973--1900-2300 HRS) at steady state conditions. The regenerator temperature profile (see Figure 12-6) and the overhead gas compositions from both reactors (see Table 12-22) show that steady state conditions were indeed achieved. Pertinent data are contained in the following Tables:

Table	Data
12-4	Gas flows, bed temperatures, jacket steam make
12-8	Feed stock compositions
12-14	Regenerator fuel char and organic pond solid compositions
12-19	Ash and attrited acceptor compositions
12-22	Reactor overhead gas analyses, solids make up and effluent rates, gas purge rates, preheat temperatures

Prior to the issuance of this report, all Run 12B data were transmitted to Consol's research center in Library, Pennsylvania, for further study. A report covering this study will be distributed at a later date.

5.3 REGENERATOR DEPOSITS

Regenerator deposits were discovered following each run in the Run 12 series. The least amount of deposit was formed during Run 12A when only a thin wall scale was generated. The most massive wall deposits were formed during Run 12B when approximately 800 pounds of agglomerated fines adhered to the bottom regenerator walls. In Runs 12C and 12D the deposit formation resulted in ball shaped agglomerations in the regenerator bed inventory. The balls were made up of an acceptor particle covered with agglomerated fines. Analyses of the wall deposits and the ball material (see Tables 12-27, 12-28, 12-29, and 12-30) show that the agglomerations were composed primarily of acceptor fines with some char ash. The sulfur content is also high.

Since oxygen breakthrough (a typical reason for regenerator deposits) did not occur in Runs 12C and 12D, other methods of deposit formation were considered. A review of the run conditions and analytical

results suggests two new possible mechanisms for deposit and "ball" formation. These are: (1) sintering of fines as a result of localized undetected hot spots; and (2) transient liquid formation caused by the presence of $CaS \cdot CaSO_4$ mixtures in the incoming acceptor.

Throughout the run series the amount of agglomeration was proportional to the time of char combustion without acceptor circulation. Figures 12-6, 12-7, and 12-8 show the regenerator temperature profiles for Runs 12B, 12C, and 12D. In Runs 12B and 12C, acceptor was not circulated during calcination. However, for Run 12C acceptor makeup provided some heat sink. As shown in Figures 12-6 and 12-7 the bottom thermocouple, TE-2312, began to drift and register a lower temperature than the upper bed thermocouple following the completion of calcination. This was the result of solids agglomeration on the thermocouple. The solids insulated the thermocouple from the fluidized bed and allowed the small gas purge on the pressure tap through which the thermocouple protruded to cool the thermocouple. Since acceptor was not made up during the initial batch calcination period for Run 12B, the bottom temperature probe became insulated almost immediately after calcining. In Run 12C the bottom temperature decline roughly corresponds to the time at which the acceptor makeup ceased, and the time when the makeup hopper was recharged.

The relatively low bed temperature experienced in Run 12A probably accounts for the lack of regenerator deposits for that run.

In Run 12D acceptor was circulated for about eight hours during the char combustion calcination period. Chemical analyses of the acceptor from the gasifier shows the presence of both CaS and $CaSO_4$ (see Table 12-12). Therefore, transient liquid could form at any regenerator condition. As acceptor showers through the char bed, some CaS is formed. This material was probably oxidized as the acceptor passes through the air-steam distributor ring in the gasifier transition zone. Since the boot heater outlet temperature was limited to 600°F, reduction of the $CaSO_4$ did not occur.

5.4 STANDLEG PLUGS

All plant shutdowns, except for Run 12A, resulted from plugging of the calcined acceptor standleg. Calcined acceptor circulation was never attempted for Run 12A. However, a plug was discovered following the run in the CD-206 line. The causes for the line plugs were both mechanical (bridging) and chemical (agglomeration) in nature. Runs 12A and 12C line agglomerations were caused by gasifier steam backflushing up the standleg. Run 12A plug was composed of transient liquid material and an agglomeration of fines and coarse acceptor particles which appeared to be slaked. It was located in the regenerator calcined acceptor outlet nozzle. Run 12C plug was 4-5 feet

long and situated just above TCV-2030. This plug was quite hard and was composed of cemented coarse acceptor particles. Microscopic examination revealed tiny crystals (probably $CaCO_3$) on the surface of the acceptor particles. These crystals undoubtedly formed when the material in the line became wet. By adjusting the differential pressure between the reactors so that gasifier steam does not enter the line, this type of plugging can be avoided.

Run 12B line plug was caused by solids bridging and was purely mechanical in nature. The bridging was caused by the high amount of attrited acceptor and char ash fines carried along with the calcined acceptor. Depending upon the pressure differential between the reactors, the balance gas and line purges to CD-206 are normally opposite in direction to solids flow. The gas flow strips fines from the acceptor and carries them back towards the regenerator which sometimes results in line bridging. Based on laboratory data, acceptor attrition should be greatly reduced after the acceptor has aged, that is, cycled through the system several times. As fines generation is reduced, the tendency for solids bridging in CD-206 should be lessened. To further eliminate this bridging, the differential pressure between the reactors should be reduced as much as possible. This will decrease the amount of line purge required for pressure balance and therefore reduce the amount of line fines stripping.

A rather unique line plug caused the Run 12D shutdown. During circulation, tacky acceptor fines coated the walls of CD-206. This scale then broke from the walls and plugged the line. The sticky fines could have been formed by one of the following three ways: (1) transient liquid ($CaSO_4 \cdot CaS$ mixture at $1700^{\circ}F$ or above); (2) sticky sintered fines due to an undetected hot spot in the regenerator bottom; or (3) $CaCO_3 \cdot Ca(OH)_2$ mixture in the temperature range of 1200° to $1300^{\circ}F$ caused by steam backflushing. All three mechanisms were possible.

5.5 HEATER PROBLEMS

Prior to Run 12, plugging of the gasifier boot heater, B-201-IA, and the downstream piping had been a problem. Sulfur contained in the recycle gases had attacked the heater tubes which resulted in the formation of iron-nickel sulfide scale. The scale either restricted the heater tubes or moved from the heater into the downstream piping and plugged the gas inlet tee under the gasifier. For the Run 12 series, the heater outlet temperature was reduced to $600^{\circ}F$ prior to char addition. This was done since literature sources indicated that sulfur attack would be eliminated at that temperature and since the recycle gas would contain some sulfur after char addition.

Before the start of Run 12A, the B-201-IA heater coils were mechanically cleaned by forcing a sand-Bentonite-water slurry at high pressure through the tubes. No plugging problems were experienced with the heater during Run 12A. During Run 12B, one of the six tube

passes became partially restricted while the heater was operating at 1150°F (during the initial acceptor charging to the system). The oxidation technique which had been successful in partially clearing the tubes during Run 11B was tried. Air was admitted to the gasifier for six hours while the boot heater was operated at 1150°-1450°F. This was done with the hope that the sulfide scale would oxidize and slough off the heater tube walls. Unfortunately, this did not work and the tube remained plugged throughout the run.

The B-201-IA heater coil was again mechanically cleaned with a Bentonite slurry following Run 12C. During the run, three tube passes had become partially restricted. Partial plugging of the boot inlet gas line at the tee section was also observed. Significantly, the line plugging occurred when the heater was operated at 600°F and probably resulted from heater tube scale accumulation in the tee section.

Run 12D was plagued by plugging of the boot inlet gas line. The first plug formed when the heater was at 1500°F prior to char addition and was serious enough that the plant had to be shut down and depressured in order to remove it. Approximately 25 pounds of oxidized pipe scale was removed from the tee section. Plugging of the tee section continued to be a problem throughout the remainder of the run. Heater temperature seemed to have little effect upon plug formation, the tee plugged when the heater was operated at 1500°F and when it was operated at 600°F. During the run, iron-nickel sulfide pipe scale was removed from the tee section through a rod-out connection.

The Run 12 experience indicates that the mechanical cleaning of the heater coils did not completely remove the pipe scale. Although additional corrosion of the heater tubes may be eliminated by operating the heater at 600°F, the remaining pipe scale continues to slough off the walls and plugs the tubes or downstream piping. Ultimately, the solution to the problem will be the replacement of the coil with a new one, and the elimination of sulfur in the recycle gas by zinc oxide absorption.

6 REGENERATOR QUENCH SYSTEM - 300 AREA

In earlier runs, the operation of the regenerator quench system had caused severe pressure upsets. These upsets were caused by the buildup and breaking away of solids in the quench tower inlet piping. The upsets complicated the regenerator fuel char control which in turn made control of the overhead CO concentration difficult. Additionally, the restrictions caused by the solids lowered the recycle compressor capacity. This reduced the amount of regenerator fluidizing gas and lessened the stripping of fines from the bed.

To improve the operation, the horizontal venturi at the quench tower inlet was installed in a vertical position. This eliminated most of the pressure upsets. Following each run, the venturi was inspected. The venturi was always found to be free of solids while the vertical section of six-inch diameter pipe downstream of the venturi always had a thin (1/4-inch thick) scale of agglomerated acceptor and char ash fines. The horizontal section of pipe which then preceded the quench tower was normally clean. Only during Run 12C was any substantial amount of solids discovered in the horizontal section. During this run, a fines agglomeration reduced the quench tower inlet from 6-inch to a 1-inch opening. However, this restriction probably resulted from overloading the venturi with solids when the ash lockhopper inlets plugged.

7 FUTURE PLANS

Based upon insights gained from the Run 12 data, the following equipment and startup procedure changes will be made for Run 13. These changes are designed to avoid all known causes for regenerator deposits and acceptor return line plugs.

(1) Acceptor will be circulated during calcination to avoid hot spots in the bottom of the regenerator.

(2) A probe containing seven thermocouples at 7-inch height increments has been installed in the bottom of the regenerator to detect bottom hot spots.

(3) The gasifier boot heater will be operated at 1500°F in order to minimize the gasifier air requirement and minimize the possibility of the formation of $CaS \cdot CaSO_4$ mixture in the gasifier.

(4) Efforts will be made to maintain an indicated regenerator bed level of 22 feet, two feet over the acceptor withdrawal. The regenerator fluidizing velocity will be reduced during startup to lower the bed expansion to about 75 percent and improve the reliability of the bed height indication.

(5) In the event acceptor circulation should cease, the regenerator will be cooled to 1600°F. This will prevent deposits from occurring after the heat sink provided by the circulating acceptor is removed.

(6) To further improve the regenerator quench system operation, a unique gas-solids-water quenching device will be installed in parallel with the quench tower venturi. Plans are to operate the quenching device with the venturi bypassed. However, should the device become plugged, the venturi will be put back in service.

The objective of Run 13 is to achieve steady state integrated plant operation and then to stabilize the system by adjusting the pressure balance, acceptor circulation rate, etc.

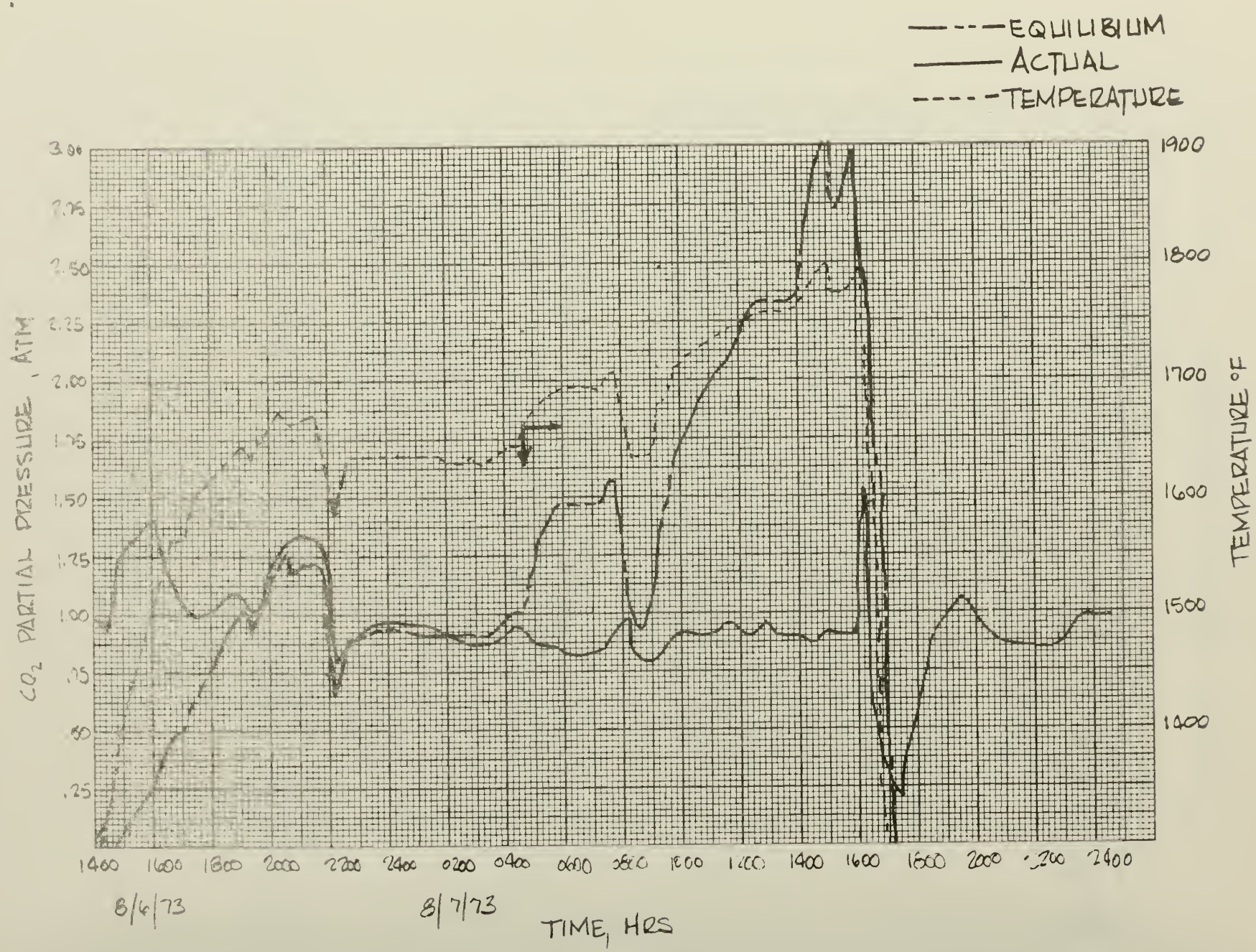

Figure 12-1. CALCINATION CURVE, RUN 12A

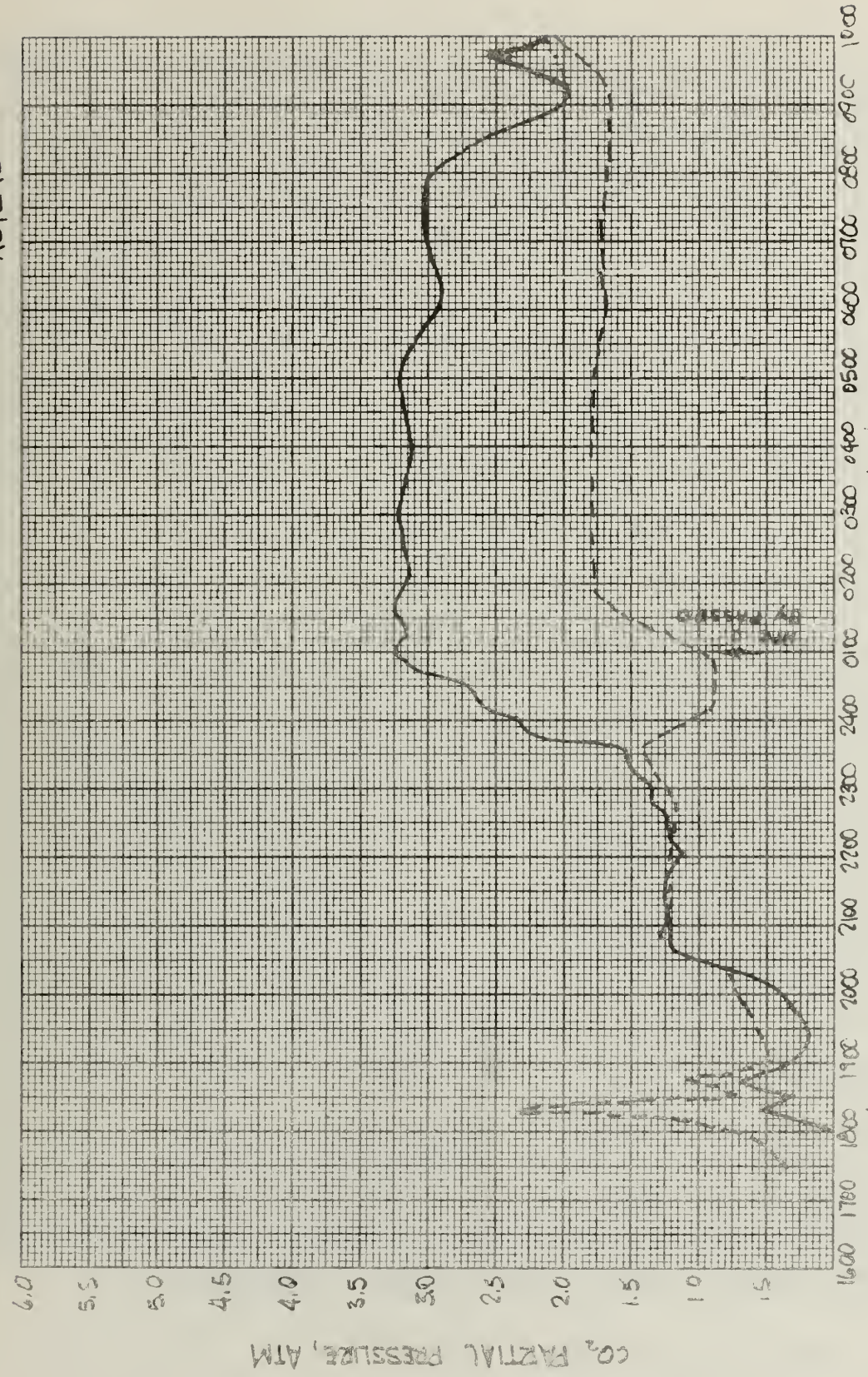

Figure 12-2. CALCINATION CURVE, RUN 12B

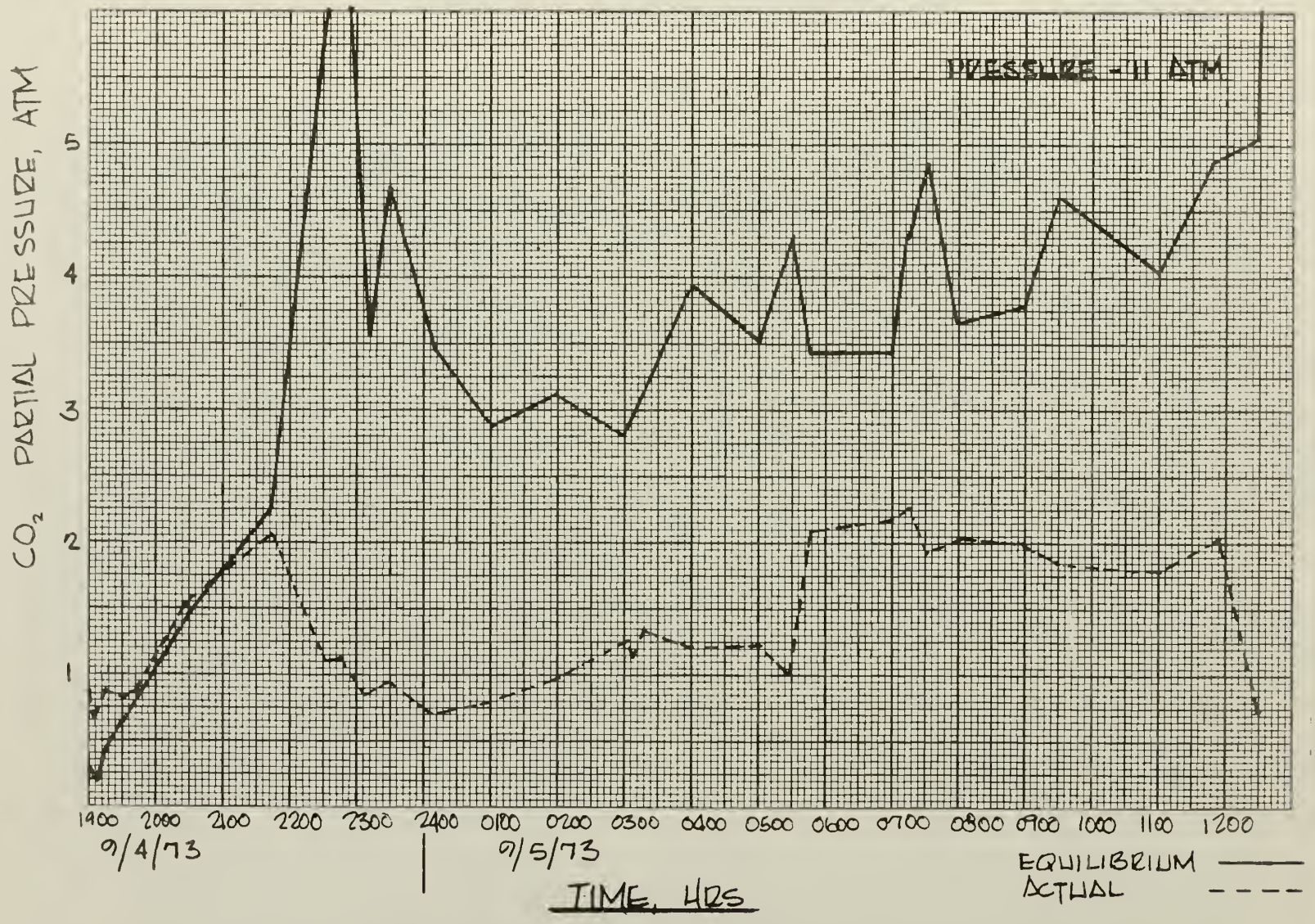

Figure 12-3. CALCINATION CURVE, RUN 12C

Figure 12-4. CALCINATION CURVE, RUN 12D

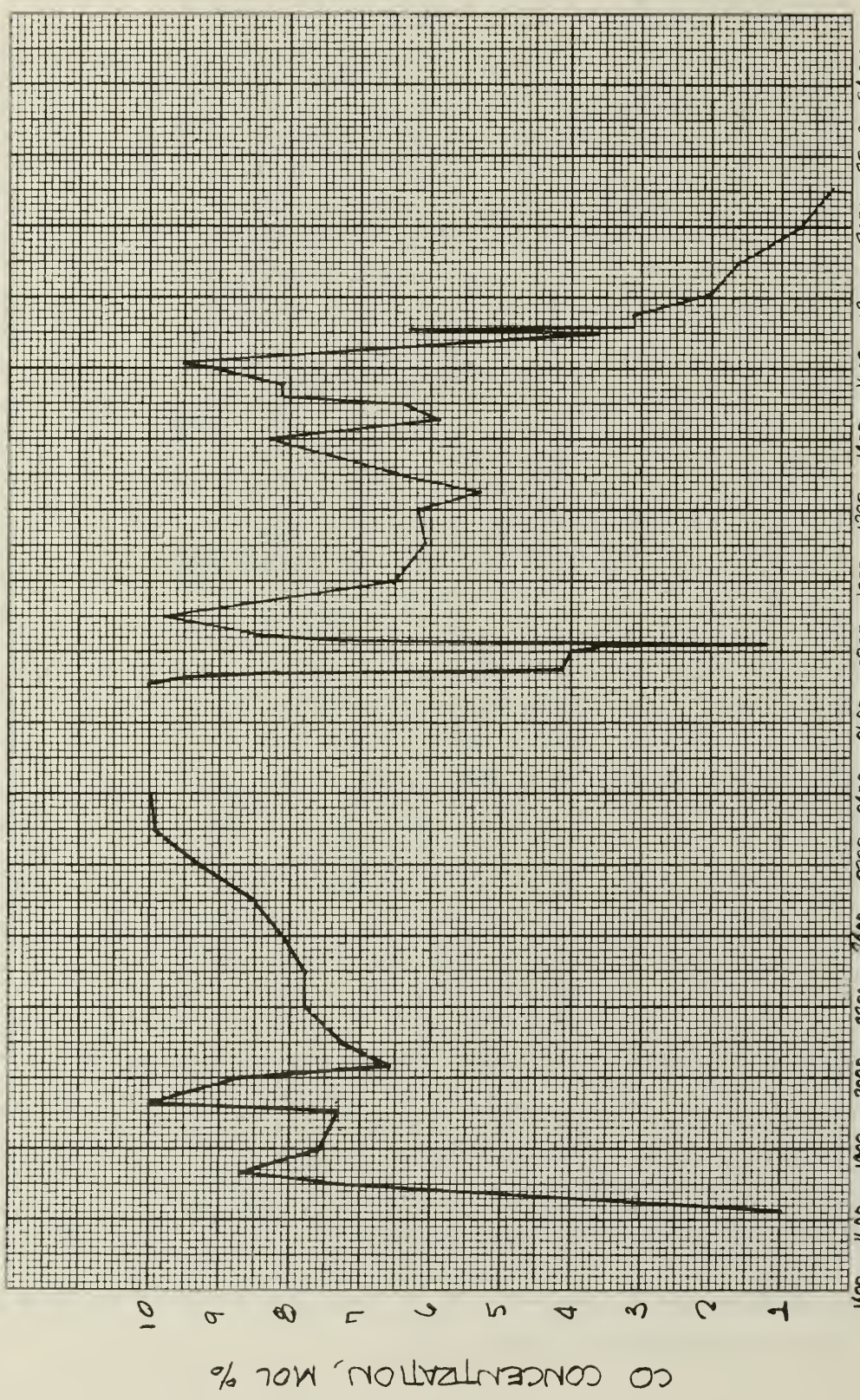

Figure 12-5. REGENERATOR CO CONCENTRATION, RUN 12A

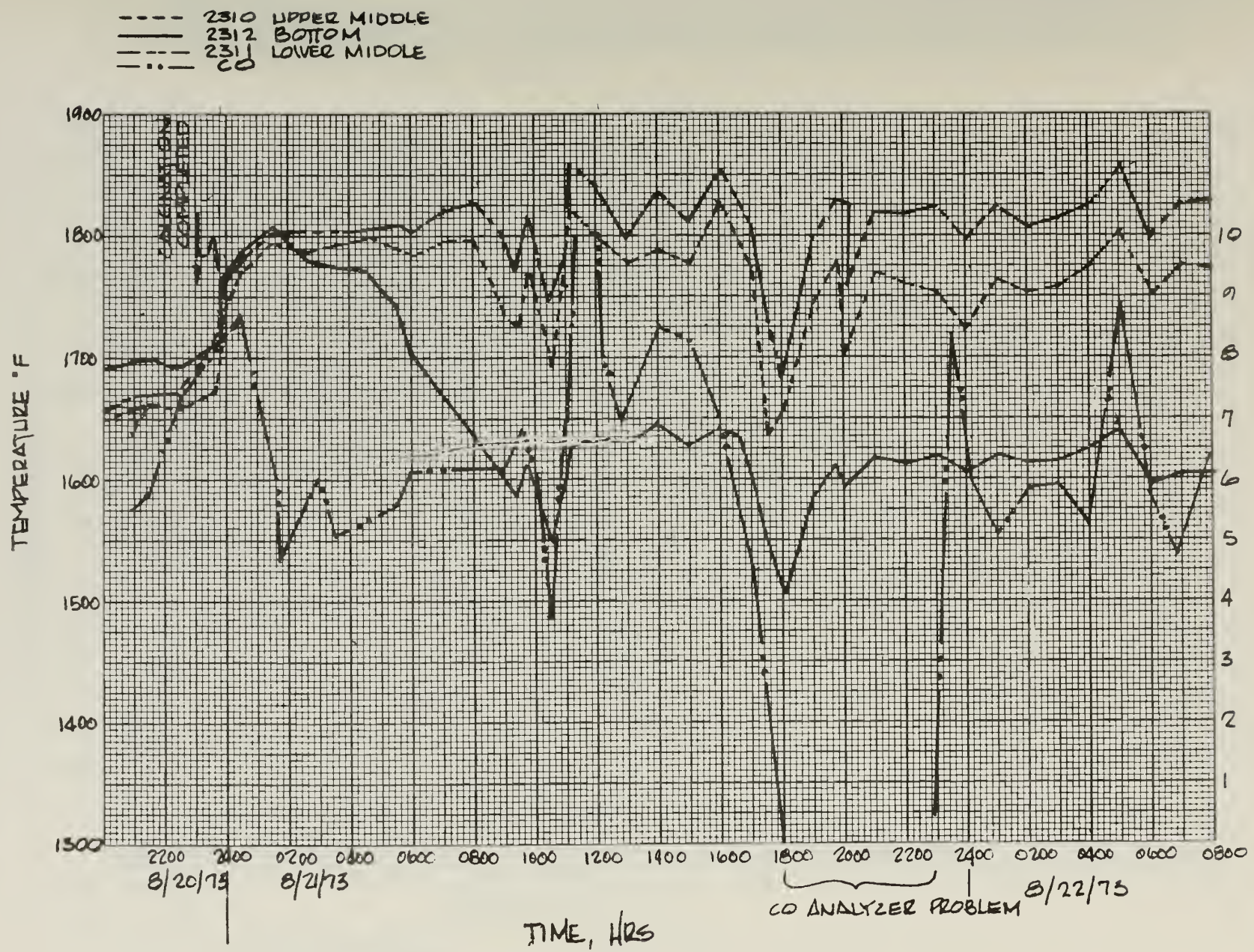

Figure 12-6. REGENERATOR BED TEMPERATURES AND CO CONCENTRATION, RUN 12B (Sheet 1 of 2)

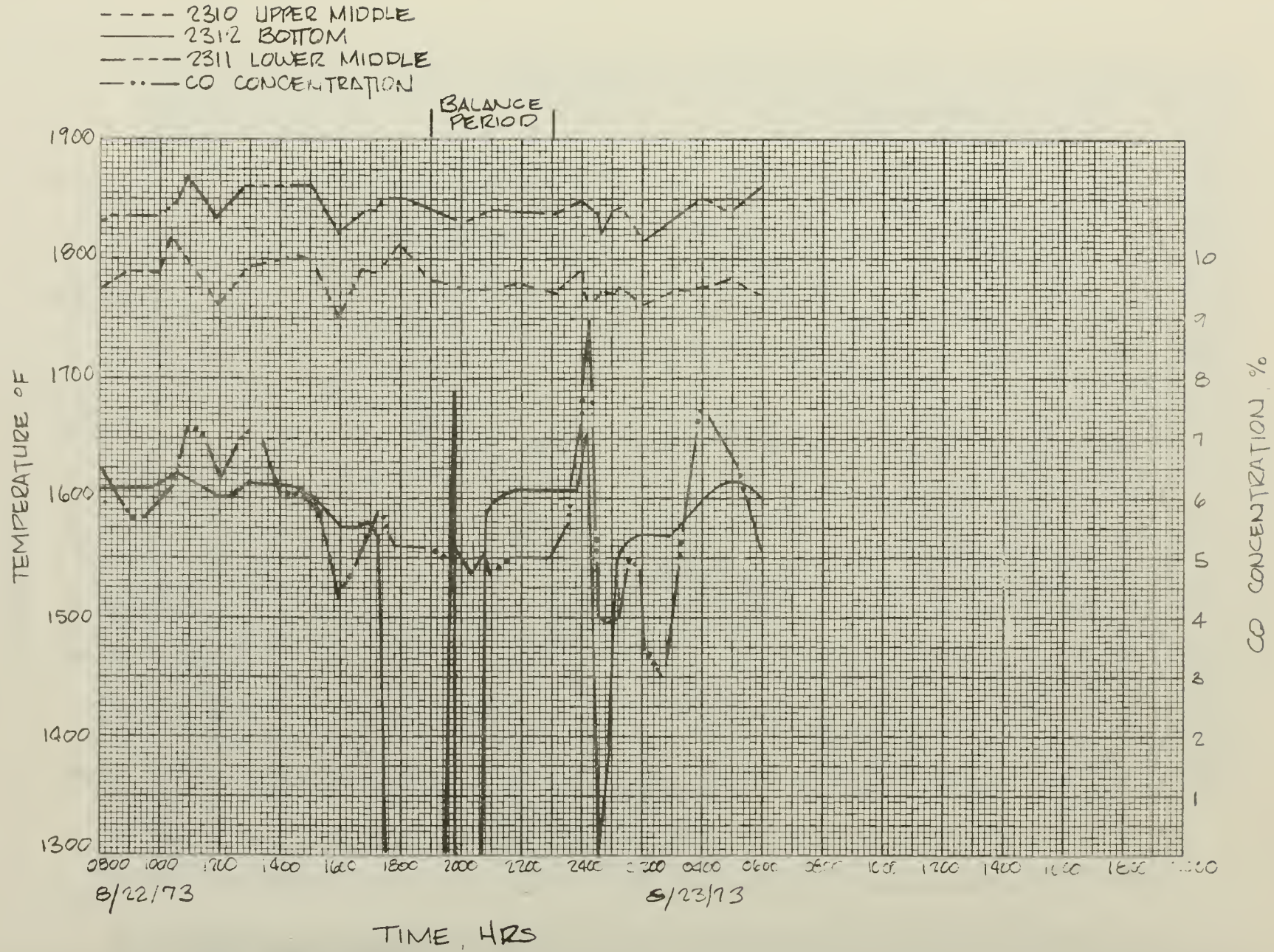

Figure 12-6. REGENERATOR BED TEMPERATURES AND CO CONCENTRATION, RUN 12B (Sheet 2 of 2)

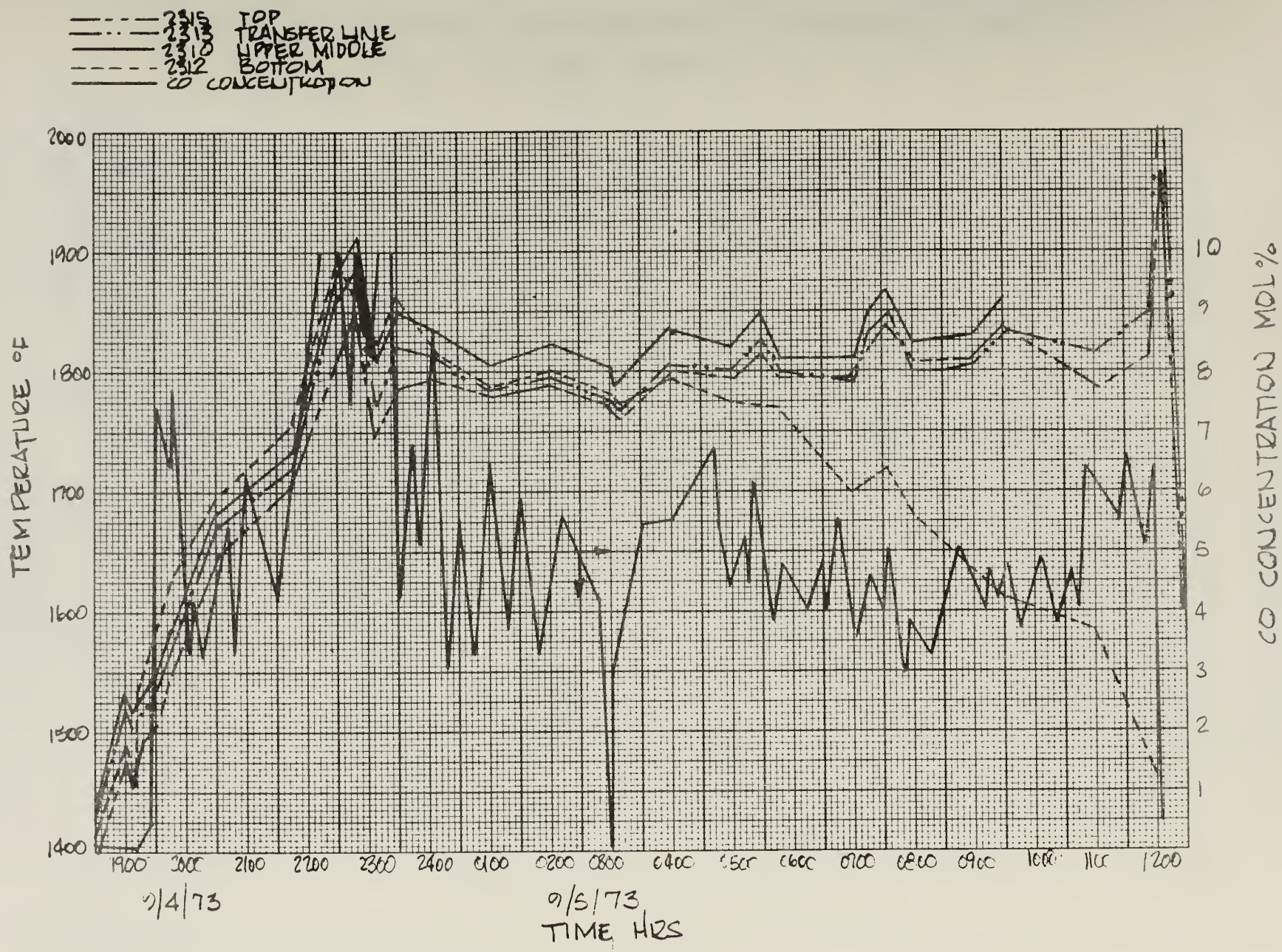

Figure 12-7. REGENERATOR BED TEMPERATURES AND CO CONCENTRATION, RUN 12C

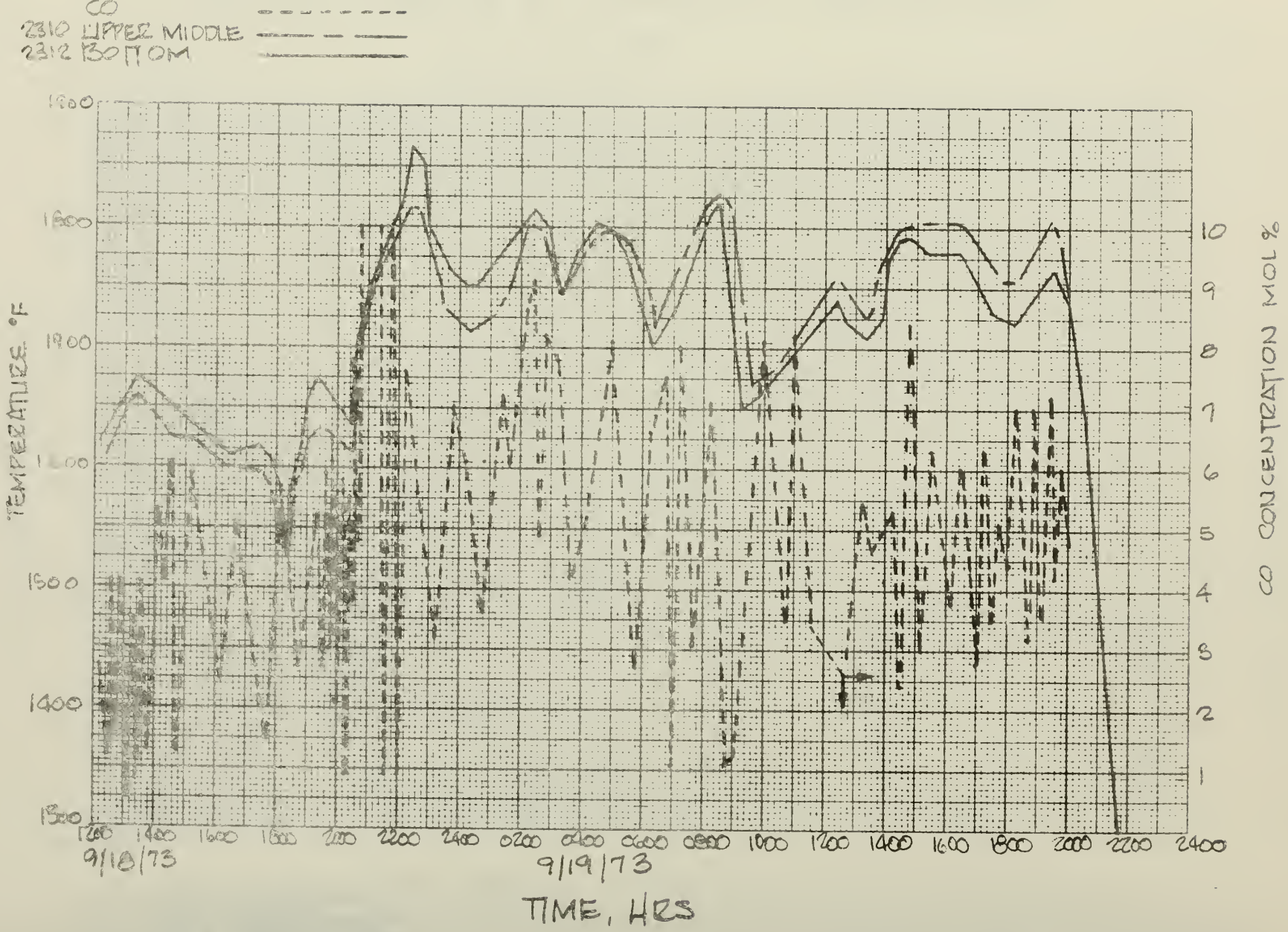

Figure 12-8. REGENERATOR BED TEMPERATURES AND CO CONCENTRATION, RUN 12D

CASE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
DATE	8/22	8/24	8/24	8/24	8/25	8/27	8/28	8/28	8/29	8/30	8/30	9/7	9/7	9/8
SCREEN SIZE		6 X 9	6 X 9	6 X 9	6 X 9	6 X 9	6 X 9	6 X 9	6 X 9	6 X 16	6 X 16	6 X 9	6 X 9	6 X 9
GRATING SIZE	1/4"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"
NO. HAMMERS	9	9	9	9	9	9	9	9	6	6	6	6	6	9
NO. DISTRIBUTORS		0	0	0	0	0	0	0	0	1	2	2	2	2
SLIDE GATE OPENING		1"	2"	3"	3"	10"	6"	2"	6"	6"	6"	6"	6"	6"
SYNTRON FEEDER SETTING		5	5	5	5	5	5	5	5	5	5	5-10	5-10	10-15
TIME LENGTH OF RUN, HRS		1.17	2.22	0.37	0.83	1.95	1.25	1.67	0.92	0.33	0.35	0.57	0.82	0.43
WEIGHT PRODUCT		525	500	505	505	500	500	505	500	545	520	500	500	510
WEIGHT FINES		3,390	3,410	1,935	2,550	3,460	2,990	3,260	1,910	380	320	805	870	930
% YIELD		13.4	12.8	20.7	16.4	12.6	14.3	13.4	20.7	58.9	61.9	38.3	36.5	35.4
$\frac{LB}{HR}$ PRODUCT		450	226	1,377	600	256	400	303	545	1,635	1,486	882	612	1,177
SAMPLE NO.	1383	1458	1454	1450	1463	1480	1485	1490	1494	1499	1503	1579	1583	1587
FEED														
MESH: +1/2	7.0	4.4	4.1	4.2	3.1	5.3	3.6	5.5	4.1	3.5	5.3	5.6	5.0	5.0
+1/4	83.7	71.8	69.9	73.5	49.7	64.5	67.3	71.6	71.0	63.5	80.3	83.1	75.5	73.0
-1/4	9.2	23.8	26.0	22.3	47.2	30.2	29.1	22.9	24.8	33.0	14.3	11.3	19.5	22.0
SAMPLE NO.	1384	1459	1455	1451	1464	1478	1486	1489	1495	1500	1504	1580	1584	1588
PRODUCT FROM CRUSHER														
MESH: +4	8.0	30.1	27.8	35.0	46.7	31.7	30.7	36.9	48.2	45.1	34.1	44.9	41.8	41.5
+6	13.2	12.8	12.3	14.4	14.5	16.8	24.8	19.8	15.9	16.8	18.3	15.9	16.0	13.9
+9	23.0	17.2	16.0	19.4	13.8	20.5	24.2	23.0	13.1	18.8	19.9	16.9	19.5	15.7
+12	9.5	8.2	7.3	7.4	6.2	7.5	6.4	6.8	4.5	6.0	6.9	5.6	7.2	6.2
+16	7.4	6.6	12.5	5.7	4.4	5.2	4.0	4.5	3.1	4.4	5.1	4.2	4.6	5.0
-16	38.7	24.9	23.7	18.1	11.0	18.0	9.9	11.0	13.2	8.9	15.7	12.5	11.0	17.6
SAMPLE NO.		1460	1456	1452	1465	1481	1487	1491	1496	1502	1506	1581	1585	1589
PRODUCT FROM SCREEN														
MESH: +6		0.2	0.5	0.2	0.4	0.0	0.3	0.2	0.3	0.1		0.6	1.1	0.9
+8		31.9	34.0	28.8	38.9	32.1	39.4	29.8	42.0		0.2	37.2	30.6	36.6
+9		44.5	44.8	41.1	41.0	46.5	41.6	47.0	39.7	36.4	32.7	30.9	32.1	29.9
+10		16.5	16.1	15.6	15.2	16.9	14.5	18.0	13.0			22.0	24.8	22.6
+12		3.4	3.1	2.9	2.9	2.8	2.5	3.3	2.3	29.6	30.3	7.2	9.0	8.1
-12		3.2	1.5	1.5	1.6	1.8	1.2	1.6	1.6	33.8	36.8	2.0	2.4	1.9
SAMPLE NO.									1497	1501	1505	1582	1586	1590
RECYCLE														
MESH: +4									54.5	55.8	52.1	69.8	46.6	58.9
+6									23.1	25.2	28.0	16.1	20.5	20.7
+9									20.7	18.0	18.8	14.1	32.0	9.1
+12									1.2	0.5	0.4	0.0	0.4	0.1
+16									0.3	0.	0.2	0.0	0.0	0.0
-16									0.1	0.4	0.4	0.0	0.5	1.2

Table 12-1. ACCEPTOR GRINDING DATA

CASE	7	9	10*	11*	12	13	14
SCREEN SIZE	6 X 9	6 X 9	6 X 16	6 X 16	6 X 9	6 X 9	6 X 9
NO. HAMMERS	9	6	6	6	6	6	9
NO. DISTRIBUTORS	0	0	1	2	2	2	2
$\frac{LB}{HR}$ FROM CRUSHER	12,143	10,458	11,280	6,899	7,601	5,645	8,785
$\frac{LB}{HR}$ RECYCLE	9,351	7,830	8,505	4,499	5,299	3,968	5,462
$\frac{LB}{HR}$ 6 X 9 PRODUCT	400	545	598	489	882	612	1,177
$\frac{LB}{HR}$ FINES	2,392	2,083	2,177	1,911	1,420	1,065	2,146
% RECYCLE	77.0	74.9	75.4	65.2	69.7	70.3	62.2
$\frac{LB}{HR}$ 6 X 9 IN RECYCLE		1,621	1,531	846	747	1,270	1,043
% YIELD (6 X 9)	14.3	20.7	21.6	20.4	38.3	36.5	35.4

*BASED ON 6 X 9 MESH MATERIAL CONTAINED IN 6 X 16 MESH MATERIAL.

Table 12-2. ACCEPTOR GRINDING MATERIAL BALANCE

DATE	8/6/73								
TIME	1200	1400	1500	1600	1700	1800	1900	2000	2100
REGENERATOR									
STEAM MAKE, LB/HR	330	330	320	320	250	260	260	100	280
DOLOMITE LIFT, SCFH	75,284	75,284	74,820	74,936	74,936	74,936	74,820	74,820	74,820
CHAR LIFT, SCFH	7,263	7,263	7,370	7,382	7,398	7,398	7,342	7,342	7,425
RECYCLE - AIR LINE, SCFH	42,380	36,860	35,002	36,630	32,560	32,560	34,146	30,081	30,081
AIR, SCFH	23,320	29,835	35,563	40,227	44,156	45,608	45,899	51,709	51,887
TOTAL	148,247	149,242	152,755	159,175	159,050	160,502	162,207	163,952	164,213
VENT RATE, SCFH	20,124	27,360	38,760	43,320	47,460	53,110	56,000	61,600	63,840
AVERAGE BED TEMPERATURE, °F	(1230)	(1375)	1410	1520	1570	1625	1650	1670	1672
BED VELOCITY, FT/SEC	2.03	2.22	2.31	2.55	2.62	2.71	2.77	2.83	2.84
BED DENSITY, LB/FT^3									
GASIFIER									
STEAM MAKE, LB/HR	0	0	0	0	0	0	0	0	0
BOOT, SCFH	32,720	33,910	33,435	32,498	32,693	32,693	32,109	31,233	30,647
STEAM, SCFH	23,896	23,896	23,896	23,896	23,896	23,896	23,896	23,896	23,896
AIR, SCFH	21,816	21,978	21,978	21,978	21,978	21,978	21,924	21,924	21,978
TOTAL	78,432	79,784	79,309	78,372	78,567	78,567	77,929	77,053	78,521
VENT RATE, SCFH	40,896	39,060	38,666	39,230	38,314	39,607	39,571	40,303	41,504
BOOT TEMPERATURE, °F	600	595	595	595	600	597	600	595	590
BED TEMPERATURE, °F	(1402)	(1390)	1398	1410	1407	1395	1392	1402	1402
BOOT VELOCITY, FT/SEC	0.936	0.966	0.952	0.952	0.935	0.932	0.919	0.889	0.869
BED VELOCITY, FT/SEC	0.798	0.807	0.805	0.801	0.802	0.797	0.789	0.784	0.799
BOOT DENSITY, LB/FT^3	57	56	57	58	58	58.5	58	57	55
BED DENSITY, LB/FT^3	42.5	41.5	41.5	40	39	39	39	40	39.5
GROSS BTU, BTU/SCF(1)									

(1) N_2 INCLUDED

Table 12-3. REGENERATOR - GASIFIER DATA, RUN 12A - 8/6/73-8/7/73, CALCINATION PERIOD (Sheet 1 of 3)

DATE	8/6/73		8/7/73						
TIME	2200	2300	0100	0200	0300	0400	0500	0600	0700
REGENERATOR									
STEAM MAKE, LB/HR	280	280	280	290	290	320	310	310	330
DOLOMITE LIFT, SCFH	74,936	74,936	74,936	74,936	74,704	74,472	74,704	74,704	74,904
CHAR LIFT, SCFH	7,425	7,425	7,425	7,425	7,425	7,425	7,425	7,425	7,425
RECYCLE - AIR LINE, SCFH	30,118	30,118	29,088	29,896	29,896	29,896	29,896	25,110	25,110
AIR, SCFH	37,895	41,976	41,251	44,446	44,752	46,800	45,922	42,120	36,270
TOTAL	150,374	154,455	157,700	156,703	156,777	158,593	147,974	149,359	143,709
VENT RATE, SCFH	43,130	49,020	49,020	51,120	50,850	56,500	59,890	51,840	39,520
AVERAGE BED TEMPERATURE, °F	1595	1640	1640	1635	1633	1652	1685	1695	1695
BED VELOCITY, FT/SEC	2.50	2.63	2.60	2.66	2.66	2.71	2.75	2.61	2.51
BED DENSITY, LB/FT^3									
GASIFIER									
STEAM MAKE, LB/HR	0	0	0	0	0	0	0	0	0
BOOT, SCFH	30,647	30,043	30,024	30,024	30,043	30,043	30,340	30,340	29,490
STEAM, SCFH	23,896	23,896	23,099	23,099	23,099	23,099	23,099	23,099	23,258
AIR, SCFH	21,654	21,654	21,816	21,816	21,816	21,816	21,816	21,762	21,762
TOTAL	76,197	75,593	74,939	74,939	74,958	74,958	75,255	75,201	74,510
VENT RATE, SCFH	38,611	40,669	42,405	41,648	41,532	40,777	39,651	41,147	37,756
BOOT TEMPERATURE, °F	590	593	590	590	590	587	580	590	592
BED TEMPERATURE, °F	1415	1428	1417	1417	1417	1425	1432	1435	1435
BOOT VELOCITY, FT/SEC	0.869	0.854	0.851	0.851	0.851	0.849	0.852	0.860	0.837
BED VELOCITY, FT/SEC	0.781	0.780	0.767	0.767	0.769	0.772	0.778	0.779	0.772
BOOT DENSITY, LB/FT^3	54	53	51.5	52.5	52	51	52	52	51.5
BED DENSITY, LB FT^3	40	39	39	39	39	39	38.5	38.5	38.5
GROSS BTU, BTU/SCF(1)		157.0							146.2

(1) N_2 INCLUDED

Table 12-3. REGENERATOR - GASIFIER DATA, RUN 12A - 8/6/73-8/7/73, CALCINATION PERIOD (Sheet 2 of 3)

DATE	8/7/73							
TIME	0800	0900	1000	1100	1200	1300	1400	1500
REGENERATOR								
STEAM MAKE, LB/HR	330	330	330	340	340	210	330	320
DOLOMITE LIFT, SCFH	74,994	74,994	74,994	74,936	74,936	74,820	74,820	74,820
CHAR LIFT, SCFH	7,342	7,370	7,209	7,248	7,276	7,178	7,242	7,308
RECYCLE - AIR LINE, SCFH	25,203	25,203	25,203	26,016	26,016	25,952	25,952	25,952
AIR, SCFH	37,184	40,670	49,676	40,960	41,251	41,832	43,575	42,122
TOTAL	144,723	148,237	157,082	149,160	149,479	149,782	151,589	150,202
VENT RATE, SCFH	39,600	47,040	45,920	46,330	45,920	45,920	48,590	48,590
AVERAGE BED TEMPERATURE, °F	1648	1685	1725	1740	1755	1760	1780	1780
BED VELOCITY, FT/SEC	2.47	2.58	2.78	2.66	2.68	2.69	2.75	2.73
BED DENSITY, LB/FT^3	50	50	50	49	48	48	45	41
GASIFIER								
STEAM MAKE, LB/HR	0	0	0	0	14	0	0	14
BOOT, SCFH	29,490	29,774	29,774	29,490	29,201	30,668	30,668	29,224
STEAM, SCFH	23,258	23,896	23,896	23,896	23,896	29,472	29,472	29,472
AIR, SCFH	21,654	21,654	21,654	21,654	21,654	21,546	21,546	21,654
TOTAL	74,402	75,324	75,324	75,040	74,751	81,685	81,685	80,350
VENT RATE, SCFH	36,392	38,176	38,910	37,914	37,914	40,362	42,604	36,291
BOOT TEMPERATURE, °F	592	595	595	595	595	598	595	595
BED TEMPERATURE, °F	1430	1425	1422	1425	1425	1432	1430	1427
BOOT VELOCITY, FT/SEC	0.837	0.841	0.848	0.840	0.832	0.876	0.873	0.832
BED VELOCITY, FT/SEC	0.769	0.776	0.775	0.773	0.770	0.845	0.844	0.829
BOOT DENSITY, LB/FT^3	51.5	52	52	53	51	52	52	50
BED DENSITY, LB/FT^3	38	38	37	37	37	37	36	35.5
GROSS BTU, BTU/SCF(1)				141.1				140.1

(1) N_2 INCLUDED

Table 12-3. REGENERATOR - GASIFIER DATA, RUN 12A - 8/6/73-8/7/73, CALCINATION PERIOD (Sheet 3 of 3)

DATE	← 8/20/73 →		← 8/21/73 →					← 8/22/73 →	
TIME	1900	2300	0500	0900	1300	1700	2100	0100	0500
REGENERATOR									
STEAM MAKE, LB/HR	210	230	240	220	230	280	280	300	300
DOLOMITE LIFT, SCFH	80,424	76,017	75,738	75,283	76,577	74,263	73,871	71,726	73,137
CHAR LIFT, SCFH	7,280	7,477	7,586	7,466	7,121	7,079	7,383	7,385	7,483
RECYCLE - AIR LINE, SCFH	30,390	27,324	28,233	28,064	26,308	25,931	26,224	15,232	12,639
AIR, SCFH	43,365	59,626	48,072	49,869	68,597	56,374	69,633	62,017	45,696
TOTAL	161,459	170,445	159,630	160,685	178,602	163,648	177,110	156,359	138,956
VENT RATE, SCFH	15,806	66,675	52,623	54,448	75,659	62,054	78,876	69,688	44,845
AVERAGE BED TEMPERATURE, °F	1510	1680	1805	1800	1810	1810	1805	1810	1845
BED VELOCITY, FT/SEC	2.577	2.955	2.929	2.942	3.285	3.010	3.250	2.876	2.595
BED DENSITY, LB/FT^3	71	55	49	52.5	55	54-60	48-60.5	57-60	53-58
GASIFIER									
STEAM MAKE, LB/HR	15	15	*	*	22	*	*	*	*
BOOT, SCFH	31,121	29,288	28,476	30,017	31,074	31,335	31,350	30,486	30,061
STEAM, SCFH	21,712	26,516	26,579	26,668	26,417	26,731	26,454	26,642	26,642
AIR, SCFH	15,001	14,653	14,653	14,881	17,095	19,188	18,976	18,705	18,907
TOTAL	67,834	70,457	69,707	71,565	74,586	77,255	76,780	75,832	75,610
VENT RATE, SCFH	19,127	23,021	24,839	23,204	28,598	34,622	33,720	33,782	33,957
BOOT TEMPERATURE, °F	770	770	845	840	880	785	785	780	775
BED TEMPERATURE, °F	1350	1340	1377	1370	1395	1440	1445	1435	1425
BOOT VELOCITY, FT/SEC	1.033	0.972	1.003	1.053	1.124	1.053	1.054	1.020	1.002
BED VELOCITY, FT/SEC	0.671	0.693	0.700	0.716	0.756	0.802	0.799	0.785	0.779
BOOT DENSITY, LB/FT^3	66.5	43	51	51.5	53.5	54.5	54.5	56	53
BED DENSITY, LB/FT^3	37	38	39	39	39.5	38.5	38	37.5	37.5
GROSS BTU, BTU/SCF(1)	125.8	139.8	148.4	153.9	154.9	160.1	158.4	144.4	162.9

(1) N_2 INCLUDED
* INSTRUMENT PROBLEM

Table 12-4. REGENERATOR - GASIFIER DATA, RUN 12B - 8/20/73-8/23/73 (Sheet 1 of 3)

DATE					8/22/73 (BALANCE PERIOD)				
TIME	0900	1300	1700	1800	1900	2000	2100	2200	2300
REGENERATOR									
STEAM MAKE, LB/HR	290	310	310	310	320	320	320	320	320
DOLOMITE LIFT, SCFH	73,950	81,139	80,826	81,968	81,570	81,570	81,693	80,832	81,175
CHAR LIFT, SCFH	7,129	7,256	7,236	7,236	7,234	7,234	7,234	7,267	7,428
RECYCLE - AIR LINE, SCFH	12,458	0	0	0	0	0	0	0	0
AIR, SCFH	55,290	39,028	45,533	47,701	45,160	45,160	45,323	45,323	43,009
TOTAL	148,827	127,423	133,595	136,904	133,964	133,964	134,250	133,422	131,612
VENT RATE, SCFH	61,318	44,678	53,285	34,357	53,405	53,373	52,019	49,394	49,810
AVERAGE BED TEMPERATURE, °F	1825	1845	1830	1850	1820	1820	1825	1830	1815
BED VELOCITY, FT/SEC	2.755	2.380	2.479	2.562	2.475	2.475	2.480	2.475	2.426
BED DENSITY, LB/FT^3	50-57	50-57	54-60	55	55.5	53.5	52.5	54	55
GASIFIER									
STEAM MAKE, LB/HR	0	0	0	0	0	0	0	0	0
BOOT, SCFH	30,332	31,437	31,736	32,387	30,109	30,109	29,948	29,948	29,457
STEAM, SCFH	26,642	26,356	26,356	26,479	26,383	26,383	26,696	26,015	26,570
AIR, SCFH	18,732	19,110	18,907	18,907	20,191	20,191	20,191	20,191	20,191
TOTAL	75,706	76,903	76,999	77,773	76,683	76,683	76,835	76,154	76,218
VENT RATE, SCFH	33,348	37,593	35,723	37,712	36,476	35,923	36,382	37,033	35,819
BOOT TEMPERATURE, °F	774	780	785	780	780	790	825	875	790
BED TEMPERATURE, °F	1440	1445	1450	1450	1435	1440	1440	1440	1435
BOOT VELOCITY, FT/SEC	1.010	1.052	1.067	1.084	1.117	1.095	1.098	1.131	1.050
BED VELOCITY, FT/SEC	0.786	0.801	0.804	0.812	0.801	0.804	0.805	0.798	0.797
BOOT DENSITY, LB/FT^3	53	57	59.5	60	60	61.5	59.5	54	55
BED DENSITY, LB/FT^3	38	37	36	36	36	36	36.5	37	36
GROSS BTU, BTU/SCF[(1)]	156.5	146.0	142	158.6	174.8	159.3	143.1	135.9	128.7

(1) N_2 INCLUDED

Table 12-4. REGENERATOR - GASIFIER DATA, RUN 12B - 8/20/73-8/23/73 (Sheet 2 of 3)

DATE	8/23/73						
TIME	0100	0500	0900	1100	1245	1400	1500
REGENERATOR							
STEAM MAKE, LB/HR	320	330	320	320	325	330	330
DOLOMITE LIFT, SCFH	81,121	80,918	81,194	81,833	81,482	81,360	82,534
CHAR LIFT, SCFH	7,286	7,371	7,174	7,198	7,216	7,312	7,291
RECYCLE - AIR LINE, SCFH	0	0	0	0	0	0	0
AIR, SCFH	46,784	41,255	56,577	54,401	53,312	60,797	32,758
TOTAL	135,191	129,544	144,945	143,431	142,010	149,470	122,583
VENT RATE, SCFH	47,836	42,612	60,279	61,135	59,636	67,920	26,378
AVERAGE BED TEMPERATURE, °F	1826	1840	1820	1827	1850	1865	1937
BED VELOCITY, FT/SEC	2.504	2.414	2.677	2.658	2.658	2.816	2.381
BED DENSITY, LB/FT^3	55	59-65	66-70	64-68	62-65	60-63	61-70
GASIFIER							
STEAM MAKE, LB/HR	0	0	0	0	0	0	0
BOOT, SCFH	31,643	31,892	32,014	33,730	32,468	39,739	39,416
STEAM, SCFH	26,529	27,001	26,705	26,871	26,616	29,863	29,582
AIR, SCFH	18,839	18,665	18,935	19,460	19,285	19,285	19,285
TOTAL	77,011	77,558	77,653	80,061	78,369	88,887	88,283
VENT RATE, SCFH	37,530	36,308	36,276	39,272	38,384	36,037	40,755
BOOT TEMPERATURE, °F	785	782	787	785	780	839	802
BED TEMPERATURE, °F	1445	1427	1443	1445	1436	1440	1435
BOOT VELOCITY, FT/SEC	1.063	1.069	1.078	1.134	1.087	1.393	1.343
BED VELOCITY, FT/SEC	0.802	0.800	0.808	0.834	0.812	0.923	0.914
BOOT DENSITY, LB/FT^3	54.5	56.5	57	57.5	59	48	57
BED DENSITY, LB/FT^3	36	36	36	36	37.5	38	37
GROSS BTU, BTU/SCF(1)	144.0	144.5	141.7	163.3	107.7	119.1	130.4

(1) N_2 INCLUDED

Table 12-4. REGENERATOR - GASIFIER DATA, RUN 12B - 8/20/73-8/23/73 (Sheet 3 of 3)

DATE	9/4/73				9/5/73			
TIME	0900	1300	1700	2000	0300	0500	0700	1100
REGENERATOR								
STEAM MAKE, LB/HR	310	330	320	340	350	350	360	365
DOLOMITE LIFT, SCFH	78,492	78,232	77,271	72,594	76,598	67,423	67,851	74,203
CHAR LIFT, SCFH	6,735	6,765	6,663	6,961	7,128	6,576	6,392	6,566
RECYCLE - AIR LINE, SCFH	27,634	26,733	25,394	15,416	15,733	15,939	15,457	15,625
AIR, SCFH	0	0	21,216	57,665	58,753	54,401	58,753	50,888
TOTAL	112,862	111,731	130,544	152,636	158,212	144,338	148,452	147,283
VENT RATE, SCFH	0	0	19,107	55,808	61,515	55,526	65,206	55,143
AVERAGE BED TEMPERATURE, °F	1045	1050	1375	1690	1780	1820	1815	1820
BED VELOCITY, FT/SEC	1.376	1.367	1.941	2.659	2.871	2.666	2.736	2.721
BED DENSITY, LB/FT^3	58-80	68-78	64-82	65-81	48-53	50-53	51-52	48-52(1)
GASIFIER								
STEAM MAKE, LB/HR	27	27	27	23	29	30	32	30
BOOT, SCFH	34,237	33,957	33,662	33,658	33,019	33,597	33,614	33,905
STEAM, SCFH	26,479	26,479	26,541	26,479	26,516	26,380	26,454	26,442
AIR, SCFH	19,956	19,956	17,219	17,219	18,597	18,732	18,732	19,439
TOTAL	80,672	80,799	77,422	77,356	78,132	78,709	78,801	79,787
VENT RATE, SCFH	25,343	24,767	25,727	26,371	30,287	29,342	28,833	31,336
BOOT TEMPERATURE, °F	790	780	785	780	785	785	785	788
BED TEMPERATURE, °F	1440	1425	1440	1430	1410	1410	1410	1425
BOOT VELOCITY, FT/SEC	1.155	1.137	1.131	1.127	1.110	1.129	1.130	1.142
BED VELOCITY, FT/SEC	0.838	0.833	0.804	0.799	0.799	0.804	0.805	0.822
BOOT DENSITY, LB/FT^3	60	59	60	55	55	58	59	51
BED DENSITY, LB/FT^3	32.5	32	31	31	31	31.5	35	35.5
GROSS BTU, BTU/SCF(2)	142.9	134.2	133.4	145.0	140.9	138.6	138.6	137.5

(1) SIDE TAP PROBLEM AT THIS READING

(2) N_2 INCLUDED

Table 12-5. REGENERATOR - GASIFIER DATA, RUN 12C - 9/4/73-9/5/73

DATE	9/17/73		9/18/73					
TIME	1700	2100	0100	0500	0845	1300	1700	2100
REGENERATOR								
STEAM MAKE, LB/HR	210	220	210	210	220	240	270	260
DOLOMITE LIFT, SCFH	83,913	85,383	85,181	85,482	82,690	82,815	85,370	83,905
CHAR LIFT, SCFH	6,454	6,628	7,284	7,303	7,230	6,854	8,502	8,978
RECYCLE - AIR LINE, SCFH	25,266	25,510	25,450	25,540	23,909	23,945	30,032	25,878
AIR, SCFH	0	0	0	0	59,841	47,872	32,593	72,897
TOTAL	155,633	117,521	117,915	118,325	173,670	161,487	156,498	191,657
VENT RATE, SCFH	0	0	0	0	34,306	52,680	29,632	92,954
AVERAGE BED TEMPERATURE, °F	1210	1196	1196	1170	1430	1680	1615	1655
BED VELOCITY, FT/SEC	1.565	1.577	1.582	1.563	2.659	2.800	2.631	3.284
BED DENSITY, LB/FT^3	65.5-80	67-81	67-83	65-83	58-80	62-80	58-77	60-77
GASIFIER								
STEAM MAKE, LB/HR	15	18	23	15	23	23	23	23
BOOT, SCFH	31,226	32,806	32,275	32,073	41,349	34,222	34,729	20,681
STEAM, SCFH	32,658	26,628	26,616	26,591	26,616	26,541	26,479	32,781
AIR, SCFH	9,708	17,568	17,370	17,358	17,727	18,162	18,096	14,085
TOTAL	73,592	77,002	76,261	76,022	85,692	78,925	80,304	67,547
VENT RATE, SCFH	10,273	28,127	24,774	25,772	23,014	26,373	24,292	28,637
BOOT TEMPERATURE, °F	704	772	770	790	780	970	738	1425
BED TEMPERATURE, °F	1122	1423	1423	1452	1445	1430	1438	1475
BOOT VELOCITY, FT/SEC	0.981	1.091	1.072	1.082	1.384	1.321	1.155	1.052
BED VELOCITY, FT/SEC	0.636	0.792	0.785	0.794	0.892	0.815	0.833	0.714
BOOT DENSITY, LB/FT^3	75	60	59	55	68	57	53	60
BED DENSITY, LB/FT^3	37	38	36	36	38	39	37.5	40
GROSS BTU, BTU/SCF(1)	42.0	139.5	127.7	130.7	103.5	131.9	123.8	173.4

(1) N_2 INCLUDED

Table 12-6. REGENERATOR - GASIFIER DATA, RUN 12D - 9/17/73-9/19/73 (Sheet 1 of 2)

DATE	← 9/19/73 →		
TIME	0100	1000	1300
REGENERATOR			
STEAM MAKE, LB/HR	270	280	270
DOLOMITE LIFT, SCFH	88,302	112,255	106,361
CHAR LIFT, SCFH	7,305	7,144	7,286
RECYCLE - AIR LINE, SCFH	0	0	0
AIR, SCFH	60,929	41,494	44,770
TOTAL	156,535	160,893	158,418
VENT RATE, SCFH	70,285	47,811	59,176
AVERAGE BED TEMPERATURE, °F	1735	1685	1740
BED VELOCITY, FT/SEC	2.784	2.796	2.824
BED DENSITY, LB/FT^3	53-60	(1)	(1)
GASIFIER			
STEAM MAKE, LB/HR	21	15	15
BOOT, SCFH	28,626	35,322	33,365
STEAM, SCFH	37,123	26,529	26,529
AIR, SCFH	10,249	19,459	19,717
TOTAL	76,498	81,310	79,611
VENT RATE, SCFH	26,254	32,078	42,646
BOOT TEMPERATURE, °F	870	820	775
BED TEMPERATURE, °F	1525	1430	1435
BOOT VELOCITY, FT/SEC	1.028	1.220	1.112
BED VELOCITY, FT/SEC	0.830	0.840	0.825
BOOT DENSITY, LB/FT^3	31	85	88
BED DENSITY, LB/FT^3	42	38.5	38
GROSS BTU, $BTU/SCF^{(2)}$	204.6	128.7	97.2

(1) SIDE TAP PROBLEM
(2) N_2 INCLUDED

Table 12-6. REGENERATOR - GASIFIER DATA, RUN 12D - 9/17/73-9/19/73 (Sheet 2 of 2)

RUN 12A
DATE 8/6 - 8/8

	DOLOMITE		CHAR	
SCREEN SIZE	6 X 16	6 X 9	SCREEN SIZE	
	WT%	WT%	WT%	
+4	0	TR	+6	0.1
4 X 6	0.3	0.6	6 X 8	1.3
6 X 8	7.3	43.7	8 X 10	4.5
8 X 9	14.0	39.5	10 X 14	9.8
9 X 10	15.1	11.1	14 X 20	13.5
10 X 12	13.5	2.1	20 X 28	15.4
12 X 14	16.5	0.8	28 X 35	15.1
14 X 16	14.5	0.4	35 X 48	11.0
16 X 20	13.4	0.3	48 X 65	7.3
20 X 24	4.2	0.1	65 X 100	5.3
24 X 28	1.0	TR	100 X 200	6.9
-28	0.8	1.2	-200	9.8
PARTICLE DENSITY, LB/CU FT	161			81.3
CHEMICAL ANALYSIS				WT%
C	-	-		71.75
H	-	-		2.43
N	-	-		0.72
O	-	-		(9.55)
S	-	-		1.95
ASH (SO_3FREE)	-	-		13.64
ASH ANALYSIS	WT%			WT%
SiO_2	4.77			36.2
CaO	56.86			33.23
MgO	36.26			12.70
Na_2O	0.36			2.01
Fe_2O_3	0.92			8.70
Al_2O_3	-			6.25
P_2O_5	-			0.03
TiO_2	-			0.40
K_2O	-			0.50
SO_3	0.82			-
R_xO	3.01			-

( ) VALUE CALCULATED BY DIFFERENCE

Table 12-7. FEEDSTOCK COMPOSITES, RUN 12A

RUN 12B
DATE 8/17 - 8/23

DOLOMITE			CHAR		
SCREEN SIZE	6 X 16	6 X 9	SCREEN SIZE		
	WT%	WT%		WT%	
+4	0	0	+6	0	
4 X 6	0	0.1	6 X 8	2.1	
6 X 8	10.0	27.4	8 X 10	5.8	
8 X 9	15.5	35.7	10 X 14	15.0	
9 X 10	16.4	16.2	14 X 20	17.9	
10 X 12	13.9	5.9	20 X 28	17.4	
12 X 14	15.1	4.9	28 X 35	12.5	
14 X 16	12.0	4.0	35 X 48	9.8	
16 X 20	10.8	3.5	48 X 65	6.4	
20 X 24	3.8	1.3	65 X 100	4.1	
24 X 28	1.1	0.4	100 X 200	4.8	
-28	0.9	0.6	-200	4.2	
					-100 MESH
PARTICLE DENSITY, LB/CU FT		168.5		81	
HEATING VALUE, BTU/LB				11,690	9,896
CHEMICAL ANALYSIS				WT%	WT%
C				74.66	64.00
H				2.51	2.21
N				0.72	
O				(8.32)	
S				1.82	2.27
ASH (SO_3 FREE)				11.97	23.30
ASH ANALYSIS				WT%	WT%
SiO_2	6.24	5.20		31.44	55.51
CaO	51.59	56.47		33.28	15.30
MgO	34.89	35.50		11.43	5.12
Na_2O	0.08	0.08		2.90	1.32
Fe_2O_3	1.03	0.91		7.16	12.61
Al_2O_3	-	1.13		13.53	9.30
P_2O_5	-	0.01		0.04	0.02
TiO_2	-	0.10		0.78	0.50
K_2O	-	0.13		0.61	0.53
SO_3	0.81	0.97		-	-
R_xO	-	-		-	-

( ) VALUE CALCULATED BY DIFFERENCE

Table 12-8. FEEDSTOCK COMPOSITES, RUN 12B

RUN 12C
DATE 9/4 - 9/5

DOLOMITE			CHAR	
SCREEN SIZE	6 X 16[1]	6 X 9[1]	SCREEN SIZE	
	WT%	WT%		WT%
+4	0	1.5	+6	0
4 X 6	0	4.4	6 X 8	2.8
6 X 8	6.1	59.5	8 X 10	6.8
8 X 9	18.5	27.9	10 X 14	15.4
9 X 10	22.4	4.6	14 X 20	18.7
10 X 12	16.0	0.6	20 X 28	17.8
12 X 14	15.1	0.2	28 X 35	12.9
14 X 16	10.8	0.3	35 X 48	10.0
16 X 20	8.8	0.2	48 X 65	5.9
20 X 24	2.0	0.2	65 X 100	3.8
-28	0.3	0.7	-200	2.0
PARTICLE DENSITY, LB/CU FT		166.5		78.5

CHEMICAL ANALYSIS	WT%
C	74.01
H	2.41
N	0.74
O	(5.51)
S	4.88
ASH (SO_3 FREE)	12.45

ASH ANALYSIS	WT%	WT%
SiO_2	5.12	40.15
CaO	57.35	31.78
MgO	35.94	8.71
Na_2O	0.10	1.83
Fe_2O_3	0.35	5.08
Al_2O_3	1.59	11.31
P_2O_5	0.0	0.01
TiO_2	0.0	0.50
K_2O	0.15	0.61
SO_3	0.82	-
R_xO	-	-

[1] TYPICAL SCREEN
( ) VALUE CALCULATED BY DIFFERENCE

Table 12-9. FEEDSTOCK COMPOSITES, RUN 12C

RUN 12D
DATE 9/18 - 9/19

	DOLOMITE		CHAR	
SCREEN SIZE	6 X 16	6 X 9	SCREEN SIZE	
	WT%	WT%		WT%
+4	0	0.1	+6	0
4 X 6	0.6	31.6	6 X 8	1.0
6 X 8	24.4	27.5	8 X 10	3.7
8 X 9	19.8	23.5	10 X 14	8.9
9 X 10	16.9	12.2	14 X 20	12.9
10 X 12	11.7	4.0	20 X 28	14.5
12 X 14	10.8	0.6	28 X 35	13.1
14 X 16	7.6	0.1	35 X 48	11.8
16 X 20	6.0	0.1	48 X 65	8.8
20 X 24	1.7	0.2(1)	65 X 100	6.3
24 X 28	0.3		100 X 200	9.2
-28	0.2		-200	10.0
PARTICLE DENSITY, LB/CU FT	171	167		70
CHEMICAL ANALYSIS				WT%
C				73.93
H				2.21
N				-
O				-
S				2.60
ASH (SO_3 FREE)				21.61
ASH ANALYSIS	WT%	WT%		WT%
SiO_2	5.08	5.39		38.67
CaO	55.18	55.40		28.78
MgO	35.50	36.50		9.09
Na_2O	0.07	0.09		1.74
Fe_2O_3	1.65	0.93		10.93
Al_2O_3	1.69	1.55		8.86
P_2O_5	0.01	0.19		0.02
TiO_2	0	0		0.51
K_2O	0.07	0.14		0.56
SO_3	0.80	1.24		-
R_xO	-	-		-
TOTAL S	-	0.50		
SULFIDE	-	0.005(2)		

(1) TOTAL -20 SCREEN

(2) AS RECEIVED BASIS

Table 12-10. FEEDSTOCK COMPOSITES, RUN 12D

RUN 12B

	CALCINED	RECARBONATED
	ACCEPTOR RETURN	ACCEPTOR RETURN
DATE	8/23	8/23
TIME	1300	1345
SCREEN SIZE	WT%	WT%
+4	0.1	0.1
4 X 6	4.0	1.6
6 X 8	16.0	18.4
8 X 9	15.6	22.9
9 X 10	15.8	19.5
10 X 12	10.8	12.2
12 X 14	9.3	10.6
14 X 16	6.1	6.1
16 X 20	5.4	4.5
20 X 24	3.1	1.5
24 X 28	3.1	0.7
-28	10.6	1.9
ACTIVITY		0.4
CARBONATION RATIO		0.4

Table 12-11. CIRCULATED ACCEPTOR, RUN 12B

RUN 12D

	CALCINED			RECARBONATED			
	ACCEPTOR RETURN			ACCEPTOR RETURN			
DATE	9/18	9/18	9/19	9/18	9/18	9/18	9/19
TIME	1200	1900	0045	1250	1415	1900	0205
SCREEN SIZE, WT%							
+4	0	0	0	0	TR	0	0
4 X 6	0.9	0.8	0.3	0.4	0.4	0.7	0.4
6 X 8	27.4	29.1	13.3	21.7	18.6	22.9	9.4
8 X 9	23.0	25.5	18.6	21.7	20.9	23.7	15.9
9 X 10	15.2	17.1	12.7	16.8	17.4	16.5	15.0
10 X 12	9.7	9.4	8.4	12.1	13.8	11.5	12.3
12 X 14	8.3	7.4	9.1	11.8	13.7	10.6	13.6
14 X 16	5.2	3.8	6.4	7.6	8.5	6.7	10.4
16 X 20	4.0	2.3	5.8	5.1	4.7	4.4	7.9
20 X 24	1.9	0.9	3.2	1.6	1.2	1.5	3.7
24 X 28	1.3	0.4	2.4	0.5	0.3	0.7	2.4
-28	3.2	2.4	19.9	0.6	0.5	0.8	9.0
PARTICLE DENSITY, LB/CU FT	120	114	101	123	119	122	125
ACTIVITY	0.85	0.65	0.35	0.85	0.80	0.75	0.60
CHEMICAL ANALYSIS, WT%							
SiO_2	4.99	5.45	6.39	5.45	5.59	5.62	6.54
CaO	55.51	54.77	53.38	55.58	55.50	54.19	52.40
MgO	36.42	35.70	34.24	36.10	35.52	35.12	32.40
Na_2O	0.09	0.09	0.10	0.06	0.06	0.07	0.12
Fe_2O_3	0.57	0.73	1.06	0.76	0.91	0.99	1.20
Al_2O_3	1.47	1.86	2.15	1.81	1.70	1.95	2.29
P_2O_5	0.49	0.39	0.05	0	0.26	0.01	0.14
TiO_2	0	0	0	0	0	0	0
K_2O	0.20	0.10	0.08	1.10	0.10	0.10	0.10
SO_3	0.48	0.91	2.55	0.98	1.21	1.95	5.34
TOTAL S(1)	0.20	0.36	1.02	0.39	0.48	0.78	2.14
SULFIDE(1)	0.01	0.12	0.39	0.002	0.19	0.39	0.66

(1) AS RECEIVED BASIS

Table 12-12. CIRCULATED ACCEPTOR, RUN 12D

RUN 12A

	REGENERATOR[1]		TO ORGANIC POND	
	FUEL CHAR			
DATE			8/6	8/7
TIME			0800	0800
SCREEN SIZE	WT%	SCREEN SIZE		
+6	0.3			
6 X 8	2.8			
8 X 10	10.3			
10 X 14	18.9			
14 X 20	22.1			
20 X 28	19.3			
28 X 35	12.2		WT%	WT%
35 X 48	7.9	+60	1.2	0.1
48 X 65	3.8	60 X 100	0.4	5.8
65 X 100	1.7	100 X 200	20.2	25.4
100 X 200	0.6	200 X 325	13.6	12.8
-200	TR	-325	64.6	55.8
CHEMICAL ANALYSIS	WT%		WT%	WT%
C	79.09		63.60	63.40
H	1.21		2.10	1.76
N	0.36		(2.77)[2]	(5.05)[2]
S	0.69		3.50	1.93

Table 12-13. GASIFIER CHAR, RUN 12A (Sheet 1 of 2)

RUN 12A

	REGENERATOR[1]	TO ORGANIC POND	
	FUEL CHAR		
CHEMICAL ANALYSIS	WT %	WT%	WT%
ASH (SO_3 FREE)	15.09	28.03	27.87
SiO_2	26.46	47.2	51.70
CaO	38.66[3]	20.6	24.51
MgO	13.16[3]	5.0	4.75
Na_2O	2.77[3]	1.7	1.70
Fe_2O_3	2.45	8.4	7.34
Al_2O_3	16.16[3]	-	10.66
P_2O_5	0.03[3]	-	0.02
TiO_2	0.29[3]	-	0.56
K_2O	0.44[3]	-	0.16
R_xO		(16.6)	

[1] COMPOSITE

[2] O + N

[3] BASED ON A SINGLE SAMPLE

( ) VALUE CALCULATED BY DIFFERENCE

Table 12-13. GASIFIER CHAR, RUN 12A (Sheet 2 of 2)

RUN 12B

DATE 8/22

	REGENERATOR[1]		TO ORGANIC POND[2]
	FUEL CHAR		
SCREEN SIZE	WT%	SCREEN SIZE	
+6	0		
6 X 8	2.9		
8 X 10	8.3		
10 X 14	18.6		
14 X 20	22.4		
20 X 28	20.1		
28 X 35	12.5		WT%
35 X 48	7.9	+60	0.6
48 X 65	4.0	60 X 100	2.3
65 X 100	2.1	100 X 200	21.1
100 X 200	1.3	200 X 325	24.9
-200	TR	-325	51.0
PARTICLE DENSITY, LB/CU FT	63.6		-
HEATING VALUE, BTU/LB	-		8,750
CHEMICAL ANALYSIS	WT%		WT%
C	80.54		57.61
H	1.40		1.27
N	-		-

Table 12-14. GASIFIER CHAR, RUN 12B (Sheet 1 of 2)

RUN 12B

DATE 8/22

	REGENERATOR[1] FUEL CHAR	TO ORGANIC POND[2]
CHEMICAL ANALYSIS	WT%	WT%
S	1.78	2.64
ASH (SO_3 FREE)	13.72	32.52
SiO_2	24.72	50.45
CaO	39.50	20.79
MgO	12.61	4.03
Na_2O	2.82	1.93
Fe_2O_3	2.66	10.90
Al_2O_3	17.52	11.05
P_2O_5	0.05	0.05
TiO_2	0.72	0.66
K_2O	0.54	0.45
SULFIDE	0.35	-

(1) COMPOSITE OF THREE SAMPLES - 0200 - 2200 HRS

(2) COMPOSITE OF FOUR SAMPLES - 0830 - 2430 HRS

1.7 - 1.9% SUSPENDED SOLIDS, 30 GALLONS PER MINUTE

Table 12-14. GASIFIER CHAR, RUN 12B (Sheet 2 of 2)

RUN 12C

DATE 9/4 - 9/5

	REGENERATOR[1]		TO ORGANIC POND[2]
	FUEL CHAR		
SCREEN SIZE	WT%	SCREEN SIZE	
+6	0		
6 X 8	2.8		
8 X 10	7.0		
10 X 14	17.2		
14 X 20	21.4		
20 X 28	19.8		
28 X 35	12.8		WT%
35 X 48	8.9	+60	0
48 X 65	5.0	60 X 100	16.2
65 X 100	3.0	100 X 200	23.9
100 X 200	1.9	200 X 325	8.0
-200	0.2	-325	52.0
PARTICLE DENSITY			
LB/CU FT	61		
CHEMICAL ANALYSIS	WT%		WT%
C	78.90		58.31
H	1.08		1.43
N + O	-		(7.11)
S	1.12		2.75

Table 12-15. GASIFIER CHAR, RUN 12C (Sheet 1 of 2)

RUN 12C

DATE 9/4 - 9/5

	REGENERATOR[1]	TO ORGANIC POND[2]
	FUEL CHAR	
CHEMICAL ANALYSIS		WT%
ASH (SO_3 FREE)		30.41
SiO_2		44.83
CaO		26.63
MgO		5.04
Na_2O		2.03
Fe_2O_3		9.83

[1] SCREENING IS COMPOSITE OF TWO SAMPLES. ANALYSIS IS A SINGLE SAMPLE

[2] COMPOSITE OF TWO SAMPLES.

Table 12-15. GASIFIER CHAR, RUN 12C (Sheet 2 of 2)

RUN 12D

DATE 9/18 - 9/19

	REGENERATOR[1]
	FUEL CHAR
SCREEN SIZE	WT%
+6	0
6 X 8	2.0
8 X 10	5.8
10 X 14	13.0
14 X 20	18.7
20 X 28	19.4
28 X 35	14.2
35 X 48	11.5
48 X 65	7.2
65 X 100	4.4
100 X 200	3.2
-200	0.5
PARTICLE DENSITY, LB/CU FT	53.9
CHEMICAL ANALYSIS	WT%
C	77.82
H	0.98
N	-
S	1.08

Table 12-16. GASIFIER CHAR, RUN 12D (Sheet 1 of 2)

RUN 12D

DATE 9/18 - 9/19

	REGENERATOR[1]
	FUEL CHAR
CHEMICAL ANALYSIS	WT%
ASH (SO_3 FREE)	16.70
SiO_2	22.69
CaO	43.04
MgO	12.86
Na_2O	1.87
Fe_2O_3	3.25
Al_2O_3	16.41
P_2O_5	0.03
TiO_2	0.53
K_2O	0.65
SO_3 AS S	0.86

[1] COMPOSITE OF SEVEN SAMPLES

Table 12-16. GASIFIER CHAR, RUN 12D (Sheet 2 of 2)

RUN 12A

DATE	8/6	8/6	8/7	8/7	8/7	8/7	8/7
TIME	1745	2000	0100	0540	1015	1400	1930
SCREEN SIZE, WT%							
+20				16.1	24.1	8.5	
20 X 24				1.1	3.6	0.8	
24 X 28				1.0	1.9	0.6	
28 X 35				2.8	4.6	1.7	
35 X 48	0.8(1)	2.9(1)	21.5(1)	6.7	5.9	3.2	3.6(1)
48 X 65	0.7	4.9	11.4	9.9	6.8	8.1	3.2
65 X 100	2.8	9.1	15.3	12.5	7.0	9.2	5.1
100 X 200	8.7	12.2	17.1	12.4	7.2	7.6	15.0
200 X 325	13.3	35.7	7.0	5.8	4.4	3.2	1.0
-325	73.7	35.2	26.3	31.6	34.3	56.9	72.2
CHEMICAL ANALYSIS, WT%							
CO_2			7.47	9.80	4.0	3.0	4.6
C			26.05	20.01	10.0	13.53	3.0
S			-	-	0.97	1.12	-
ASH (SO_3 FREE)			62.68	69.77	82.37	79.36	90.1
ASH ANALYSIS, WT%							
SiO_2			17.63	15.19	15.14	14.28	14.28
CaO^2			39.89	46.69	48.24	46.76	47.14
MgO			-	-	28.42	28.07	28.12
Na_2O			1.59	1.53	0.60	0.93	0.98
Fe_2O_3			3.00	2.55	2.24	3.04	3.43
Al_2O_3			-	-	4.95	6.34	-
P_2O_5			-	-	0.02	0.03	-
TiO_2			-	-	0.14	0.25	-
K_2O			-	-	0.24	0.32	-
R_xO			-	-	-	-	(6.05)
SO_3			5.60	4.05	4.66	5.01	3.26

(1) TOTAL +48

( )VALUE CALCULATED BY DIFFERENCE

Table 12-17. ASH AND ATTRITED ACCEPTOR, RUN 12A

RUN 12A

DATE 8/7
TIME 1400

SCREEN SIZE	+48	48 X 65	65 X 100	100 X 200	200 X 325	-325
CHEMICAL ANALYSIS, WT%						
CO_2	3.23	3.83	3.93	4.09	3.90	1.63
C	11.13	43.10	40.53	19.99	3.42	0.65
ASH (SO_3 FREE)	80.10	45.22	48.96	69.82	88.60	93.62
ASH ANALYSIS, WT%						
SiO_2	10.63	24.66	25.33	21.65	14.34	9.77
CaO^2	51.72	38.63	36.85	39.77	45.96	51.24
MgO	32.02	16.53	19.48	22.05	29.97	30.28
Na_2O	0.37	3.51	2.94	2.22	0.95	0.31
Fe_2O_3	1.06	2.10	3.20	3.96	3.70	3.16
Al_2O_3	3.34	13.05	12.06	9.53	5.53	5.46
P_2O_5	0.02	0.04	0.01	0.01	0.02	0.02
TiO_2	0.08	0.32	0.11	0.30	0.20	0.30
K_2O	0.20	1.17	0.92	0.68	0.21	0.07
SO_3	6.46	14.67	10.20	7.52	3.78	3.78

DATE 8/7
TIME 1930

SCREEN SIZE	+48	48 X 65	65 X 100	100 X 200	200 X 325	-325
CHEMICAL ANALYSIS, WT%						
CO_2	11.24	10.19	6.99	9.84	10.75	3.11
C	11.44	28.23	21.80	8.65	2.00	1.10
ASH (SO_3 FREE)	70.82	58.49	62.48	78.41	84.26	92.56
ASH ANALYSIS, WT%						
SiO_2	16.55	30.41	26.96	21.93	18.43	12.58
CaO	45.34	31.52	34.59	38.47	41.82	46.95
Na_2O	0.75	2.10	2.49	1.84	1.22	0.63
Fe_2O_3	2.09	4.89	4.63	3.74	3.02	3.33
SO_3	8.15	4.90	4.96	3.67	3.30	3.31

Table 12-18. ASH AND ATTRITED ACCEPTOR, CHEMICAL ANALYSIS AS A FUNCTION OF SCREEN SIZE, RUN 12A

RUN 12B

DATE 8/22

		BALANCE PERIOD			
TIME, HRS.		1700	1900	2100	2330
SCREEN SIZE, WT%	COMPOSITE(1)				
+48	0.9	0.3	0.3	0.7	2.7
48 X 65	2.1	1.1	1.5	1.8	3.8
65 X 100	6.6	5.3	3.9	6.4	10.9
100 x 200	7.4	5.6	7.0	7.3	9.5
200 x 325	39.4	9.8	18.9	65.3	43.4
-325	43.8	57.9	68.4	18.7	30.3

CHEMICAL ANALYSIS	WT%
CO_2	1.87
C	1.80
S	1.35
ASH (So_3 FREE)	93.18

ASH ANALYSIS	WT%
SiO_2	12.59
CaO	50.72
MgO	28.04
Na_2O_3	0.80
Fe_2O_3	2.61
Al_2O_3	5.98
P_2O_5	0.03
TiO_2	0.24
K_2O	0.33
SO_3	3.24
SULFIDE	0.07

(1) COMPOSITE OF THE FOUR SAMPLES LISTED.

Table 12-19. ASH AND ATTRITED ACCEPTOR, RUN 12B

RUN 12C

DATE 9/5

SCREEN SIZE	WT%
+48	13.3
48 X 65	5.9
65 X 100	9.5
100 X 200	17.4
200 X 325	21.6
-325	32.3

CHEMICAL ANALYSIS	WT%
CO_2	4.41
C	0.67
ASH (SO_3 FREE)	93.49

ASH ANALYSIS	WT%
SiO_2	12.82
Na_2O	0.95
SO_3	1.51

Table 12-20. ASH AND ATTRITED ACCEPTOR, RUN 12C

RUN 12D

DATE	9/18	9/18	9/19	9/19
TIME	2000	2400	0145	0330
SCREEN SIZE, WT%				
+48	9.9	3.7	26.1	33.5
48 X 65	11.1	4.5	8.8	7.2
65 X 100	13.1	7.2	10.4	8.8
100 X 200	18.8	16.7	15.0	13.2
200 X 325	20.5	41.3	10.9	11.1
-325	26.6	26.6	28.7	26.3
CHEMICAL ANALYSIS, WT%				
CO_2	11.66	18.62	9.13	2.26
C	2.92	4.15	1.25	TR
S	0.88	0.82	1.38	1.83
ASH (SO_3 FREE)	79.35	75.43	86.97	94.66
ASH ANALYSIS, WT%				
SiO_2	12.89	11.56	12.63	12.28
CaO^2	47.83	48.73	49.71	46.16
MgO	29.29	31.06	30.08	29.19
Na_2O	0.94	0.66	0.72	0.64
Fe_2O_3	2.37	2.34	2.50	6.66
Al_2O_3	4.99	4.57	3.91	4.27
P_2O_5	0.02	0.02	0.02	0.01
TiO_2	0.24	0.19	0.16	0.27
K_2O	1.08	1.07	0.58	0.50
SO_3	2.52	2.33	2.96	3.15
SO_3 AS S	0.82	0.72	1.06	1.23

Table 12-21. ASH AND ATTRITED ACCEPTOR, RUN 12D

RUN 12B

DATE 8/22

GASIFIER OVERHEAD

TIME	O_2	CO	CO_2	N_2+Ar	H_2	CH_4	H_2S	H_2O
1900	0.0	12.0	15.0	47.7	23.0	2.2	0.1	24.3
2100	0.0	13.6	15.8	45.6	22.3	2.6	0.1	22.3
2300	0.0	12.4	16.7	48.6	19.7	2.4	0.2	23.4

REGENERATOR OVERHEAD

TIME	O_2	CO	CO_2	N_2+Ar	H_2
1900	0	6.0	16.2	77.8	0.3
2100	0	6.3	16.2	77.4	0.3
2300	0.6	8.6	16.2	72.8	0.3

REGENERATOR RECYCLE GAS

TIME	O_2	CO	CO_2	N_2+Ar	H_2
1900	0.2	7.9	14.2	76.6	1.1
2300	0.2	8.0	14.4	76.6	0.6

GAS COMPONENTS ARE EXPRESSED IN MOLE PERCENT CALCULATED ON A DRY BASIS

WATER IS MOL PERCENT CALCULATED ON A TOTAL GAS VOLUME BASIS

Table 12-22. BALANCE PERIOD, GAS ANALYSES, HEAT AND MATERIAL BALANCE DATA, RUN 12B (Sheet 1 of 2)

DATE	8/22/73
TIME	1900 - 2300 HRS
SOLIDS MAKE UP RATE, LB/HR	
RAW DOLOMITE	284
RAW CHAR	
BASED ON FEEDER CALIBRATION	1,010
BASED ON WEIGH CELL RECORDS	1,106
SOLIDS WITHDRAWAL RATE, LB/HR	
ASH AND ATTRITED ACCEPTOR	282
WATER TO ORGANIC POND, GPM	30
WT % SOLIDS IN ORGANIC POND WATER	1.7-1.9
PURGE RATES, SCFH	
GASIFIER	
GASIFIER RECYCLE GAS	0
INERT GAS (12% CO_2, 88% N_2)	5,230
REGENERATOR	
REGENERATOR RECYCLE GAS	1,800
INERT GAS	1,020
PREHEAT TEMPERATURES, °F	
GASIFIER	
BOOT HEATER OUTLET	605
SIDE FLOW HEATER OUTLET	1580
CHAR FEED	422
REGENERATOR	
ACCEPTOR LIFT HEATER OUTLET	1410
AIR HEATER OUTLET	175
CHAR LIFT HEATER OUTLET	1020
ACCEPTOR MAKE UP	AMBIENT (80)

Table 12-22. BALANCE PERIOD, GAS ANALYSES, HEAT AND MATERIAL BALANCE DATA, RUN 12B (Sheet 2 of 2)

RUN 12A

DATE 8/7 - 8/8

	REGENERATOR DUMP			GASIFIER DUMP[1]		
	TOP	BOTTOM		TOP	MIDDLE	BOTTOM
SCREEN SIZE, WT%						
+4	0	0	+6	0.1	0.1	0.2
4 X 6	0.2	0.2	6 X 8	2.0	0.7	7.1
6 X 8	5.9	8.0	8 X 10	6.0	2.6	21.3
8 X 9	12.2	16.4	10 X 14	12.2	8.1	23.7
9 X 10	17.3	18.7	14 X 20	16.9	14.9	26.2
10 X 12	12.7	12.8	20 X 28	18.5	20.6	12.2
12 X 14	12.7	11.9	28 X 35	14.6	18.6	6.9
14 X 16	9.2	8.0	35 X 48	11.5	15.2	4.4
16 X 20	8.5	6.6	48 X 65	7.2	9.8	1.9
20 X 24	4.4	3.2	65 X 100	4.7	6.1	0.8
24 X 28	3.0	2.1	100 X 200	3.7	3.0	0.4
-28	14.0	12.2	-200	2.5	0.3	0.6
PARTICLE DENSITY, LB/CU FT	110	108		61.5[2]	62.8[2]	62.7[2]
ACTIVITY	0.32	0.33				
CARBONATION RATIO	0.14	0.15				
CHAR, PERCENT				84	86	50[3]

Table 12-23. SOLIDS REMOVED AT SHUTDOWN, RUN 12A (Sheet 1 of 2)

RUN 12A

DATE 8/7 - 8/8

	REGENERATOR DUMP		GASIFIER DUMP[1]		
	TOP	BOTTOM	TOP	MIDDLE	BOTTOM
CHEMICAL ANALYSIS, WT%					
C			76.02	78.5	79.0
H			1.44	1.20	1.0
N			-	0.35	-
O			-	(4.04)	-
S			0.57	0.66	0.74
ASH (SO_3 FREE)			14.86	15.25	15.58
ASH ANALYSIS, WT%					
SiO_2	6.31	8.05	25.85	26.70	27.76
CaO	49.86	49.02	-	37.67	-
MgO	31.31	30.72	-	13.47	-
Na_2O	0.08	0.10	-	2.79	-
Fe_2O_3	0.93	0.95	1.95	1.83	2.54
Al_2O_3	-	-	-	16.13	-
P_2O_5	-	-	-	0.05	-
TiO_2	-	-	-	0.56	-
K_2O	-	-	-	0.46	-
SO_3	10.73	10.66	-	-	-
R_xO	0.78	0.50	-	-	-
SO_3			10.68	11.20	12.47

(1) THREE OF FIVE TOTE BINS ANALYZED. CHEMICAL ANALYSIS DETERMINED ON "CHAR" FRACTIONS.
(2) DETERMINED ON "CHAR" FRACTION.
(3) ACCEPTOR FRACTION: 4.49% SiO_2, 6.96% SO_3

( )VALUES CALCULATED BY DIFFERENCE

Table 12-23. SOLIDS REMOVED AT SHUTDOWN, RUN 12A (Sheet 2 of 2)

RUN 12B

DATE 8/23

	REGENERATOR DUMP			GASIFIER DUMP[1]	
	TOP	MIDDLE	BOTTOM		
SCREEN SIZE, WT%					
+6	4.4	6.0	4.5	+8	2.1
6 X 8	19.4	20.9	19.4	8 X 10	5.1
8 X 9	17.9	18.6	18.4	10 X 14	12.3
9 X 10	15.7	17.3	16.5	14 X 20	18.8
10 X 12	9.1	10.3	10.2	20 X 28	21.5
12 X 14	9.9	8.8	8.6	28 X 35	16.2
14 X 16	5.3	5.8	5.8	35 X 48	11.9
16 X 20	4.8	4.8	4.9	48 X 65	6.7
20 X 24	3.1	2.7	2.9	65 X 100	3.7
24 X 28	3.6	2.1	2.5	100 X 200	1.8
-28	6.8	2.7	6.3	-200	0.1
PARTICLE DENSITY, LB/CU FT	128.6	129.0	131.0		60.4[2]
ACTIVITY	0.14	0.10	0.12		
CARBONATION RATIO	0.13	0.10	0.12		

Table 12-24. SOLIDS REMOVED AT SHUTDOWN, RUN 12B (Sheet 1 of 2)

RUN 12B

DATE 8/23

	REGENERATOR DUMP			GASIFIER DUMP[1]
	TOP	MIDDLE	BOTTOM	
CHEMICAL ANALYSIS				WT%
C				78.01[2]
H				1.06
N + O				(3.66)
S				0.92
ASH (SO_3 FREE)				16.35
ASH ANALYSIS, WT%				
SiO_2	11.39	11.10	11.09	25.68
CaO	45.03	44.52	45.50	38.34
MgO	28.59	27.97	28.10	12.61
Na_2O	0.35	0.32	0.33	2.93
Fe_2O_3	1.80	1.62	1.77	2.65
Al_2O_3	4.30	4.50	4.35	17.35
P_2O_5	0.03	0.03	0.03	0.05
TiO_2	0.17	0.16	0.12	0.58
K_2O	0.18	0.26	0.27	0.52
SO_3	9.01	9.33	9.14	-
SO_3				11.80

(1) COMPOSITE OF FOUR TOTE BINS
(2) BASED ON "CHAR" SAMPLES

( )VALUE CALCULATED BY DIFFERENCE

Table 12-24. SOLIDS REMOVED AT SHUTDOWN, RUN 12B (Sheet 2 of 2)

RUN 12C

DATE 9/6

	REGENERATOR DUMP			GASIFIER DUMP		
	TOP[1]	BOTTOM[2]		TOP	MIDDLE[3]	BOTTOM
SCREEN SIZE, WT%						
+4	16.4	50.7	+8	3.1	2.0	14.4
4 X 6	2.9	4.9	8 X 10	6.8	3.9	21.7
6 X 8	8.3	11.1	10 X 14	15.4	10.2	14.7
8 X 9	7.9	8.0	14 X 20	19.4	17.0	9.1
9 X 10	7.3	5.6	20 X 28	19.1	21.3	10.0
10 X 12	5.8	2.8	28 X 35	13.1	17.6	9.8
12 X 14	6.5	2.4	35 X 48	9.8	13.6	9.1
14 X 16	5.5	1.5	48 X 65	6.2	7.9	5.6
16 X 20	5.4	1.2	65 X 100	4.0	4.4	3.2
20 X 24	3.5	0.6	100 X 200	2.6	2.2	1.7
24 X 28	3.6	0.5	-200	0.5	0.1	0.6
-28	26.9	10.6				
PARTICLE DENSITY, LB/CU FT				58.9	59.1	-
CHAR, PERCENT				85	80	20
CHEMICAL ANALYSIS, WT%						
C				77.93	80.04	
H				0.96	1.05	
N + O				(4.15)	(2.39)	
S				0.64	0.61	

Table 12-25. SOLIDS REMOVED AT SHUTDOWN, RUN 12C (Sheet 1 of 2)

RUN 12C

DATE 9/6

	REGENERATOR DUMP		GASIFIER DUMP		
	TOP[1]	BOTTOM[2]	TOP	MIDDLE[3]	BOTTOM
CHEMICAL ANALYSIS			WT%	WT%	
ASH (SO_3 FREE)			16.32	15.92	
Ash Analysis, Wt%					
SiO_2	11.68	9.46	24.70	26.02	7.21[4]
CaO	50.68	51.18	42.88	41.18	52.32
MgO	31.14	33.27	13.31	12.32	33.00
Na_2O	0.37	0.18	0.20	2.12	0.10
Fe_2O_3	1.54	1.36	3.39	3.12	1.12
Al_2O_3	3.34	2.97	15.44	15.44	42.11
P_2O_5	0.05	0.03	0.05	0.04	0.02
TiO_2	0	0	0.47	0.41	0.08
K_2O	0.36	0.25	0.45	0.50	0.21
SO_3	2.03	2.90	-	-	4.66
SO_3			8.67	8.40	-
MOL CaS Per 100 MOL Ca	0.17	0.18			1.46

(1) CHEMICAL ANALYSIS OF -28 SCREEN
(2) CHEMICAL ANALYSIS OF 6 X 9 SCREEN
(3) COMPOSITE OF TWO TOTE BINS
(4) ANALYSIS OF ACCEPTOR FROM BOTTOM GASIFIER

( )VALUE CALCULATED BY DIFFERENCE

Table 12-25. SOLIDS REMOVED AT SHUTDOWN, RUN 12C (Sheet 2 of 2)

RUN 12D

DATE 9/20

	REGENERATOR DUMP			GASIFIER DUMP
	TOP	BOTTOM		COMPOSITE(1)
SCREEN SIZE, WT%				
+4	1.1	3.4	+6	0
4 X 6	2.0	2.8	6 X 8	2.2
6 X 8	13.8	15.9	8 X 10	5.2
8 X 9	14.5	16.2	10 X 14	14.2
9 X 10	14.0	14.7	14 X 20	20.0
10 X 12	9.4	9.0	20 X 28	21.6
12 X 14	9.0	8.0	28 X 35	14.8
14 X 16	6.3	5.4	35 X 48	10.8
16 X 20	5.3	4.5	48 X 65	6.0
20 X 24	2.9	2.4	65 X 100	3.3
24 X 28	2.5	1.8	100 X 200	1.8
-28	19.1	15.9	-200	0.1
PARTICLE DENSITY, LB/CU FT	111.1	111.1		59.7
ACTIVITY	0.25	0.25		
CHAR, PERCENT				79

CHEMICAL ANALYSIS	WT%
C	76.15
H	0.96
S	1.12

Table 12-26. SOLIDS REMOVED AT SHUTDOWN, RUN 12D (Sheet 1 of 2)

RUN 12D

DATE 9/20

	REGENERATOR DUMP		GASIFIER DUMP
	TOP	BOTTOM	COMPOSITE[1]
CHEMICAL ANALYSIS			
ASH (SO_3 FREE)			15.67
ASH ANALYSIS, WT%			
SiO_2	7.15	7.30	23.78
CaO	50.75	51.20	41.31
MgO	34.42	32.58	12.80
Na_2O	0.12	0.11	2.21
Fe_2O_3	1.23	1.33	2.24
Al_2O_3	2.50	2.61	16.35
P_2O_5	0	0	0.04
TiO_2	0.05	0.05	0.59
K_2O	0.12	0.11	0.37
SO_3	3.66	3.70	-
SO_3			14.34
SO_3 AS S			1.05

(1) CHEMICAL ANALYSIS RUN ON "CHAR" FRACTION

Table 12-26. SOLIDS REMOVED AT SHUTDOWN, RUN 12D (Sheet 2 of 2)

RUN 12A

DATE 8/8

	REGENERATOR	GASIFIER
	AGGLOMERATE WT%	DEPOSIT WT%
SiO_2	7.83	25.80
CaO	50.05	34.33
MgO	30.42	12.89
Na_2O	0.27	2.29
Fe_2O_3	1.18	4.20
Al_2O_3	3.05	20.50
P_2O_5	0.04	0.06
TiO_2	0.05	0.50
K_2O	0.17	0.33
R_xO	-	-
SO_3	7.49	0.93

Table 12-27. DEPOSITS, RUN 12A

RUN 12B

DATE 8/23

	REGENERATOR		LINE CD-206	
	BOTTOM WT%	TOP WALL WT%	INSIDE[1] WT%	OUTSIDE[2] WT%
SiO_2	9.68	9.42	7.90	7.42
CaO	42.78	51.23	52.90	52.41
MgO	24.33	28.24	29.72	28.97
Na_2O	0.34	0.36	0.62	0.27
Fe_2O_3	2.65	1.98	1.68	1.29
Al_2O_3	4.89	4.81	4.53	4.39
P_2O_5	0.01	0.01	0.02	0.02
TiO_2	0.20	0.22	0.15	0.22
K_2O	0.11	0.12	0.07	0.11
SO_3	16.52	5.08	2.45	5.71
TOTAL S	6.61	2.03	0.98	2.28
SULFIDE	0.045	0.02	0.01	0.027

(1) DEPOSIT REMOVED FROM INSIDE THE TRANSFER LINE

(2) DEPOSIT REMOVED FROM THE OUTSIDE OF THE LINE WITHIN THE REGENERATOR

Table 12-28. DEPOSITS, RUN 12B

RUN 12C

	PLUG CD-206 WT%	BALLS WT%
SiO_2	6.61	6.70
CaO	50.77	53.95
MgO	36.79	30.70
Na_2O	0.17	0.20
Fe_2O_3	1.95	1.40
Al_2O_3	1.99	3.22
P_2O_5	0.03	0.02
TiO_2	0.07	0.15
K_2O	0.33	0.05
SO_3	1.28	4.05
MOL CaS Per 100 MOL Ca		0.12

Table 12-29. DEPOSITS, RUN 12C

RUN 12D

DATE 9/20

	LINE CD-206[1]			GASIFIER WALL[2]
	TAN GLAZE WT%	DUNE WT%	DARK GRAY WT%	-100 M WT%
CO_2	17.26	18.09	15.71	
H_2O	0.57	1.40	0.96	
SiO_2	7.10	7.33	7.00	35.58
CaO	54.09	54.06	54.24	27.90
MgO	30.06	29.99	29.58	11.92
Na_2O	0.17	0.18	0.15	0.90
Fe_2O_3	1.86	1.66	2.88	9.11
Al_2O_3	3.43	3.41	3.38	7.49
P_2O_5	0.02	0.02	0.02	0
TiO_2	0	0	0	0.37
K_2O	0.15	0.09	0.08	0.18
SO_3	3.19	3.40	2.69	6.60
SULFIDE	0.30	0.37	0.25	
CrO	0.014	0.012	0.011	
NiO	0.015	0.013	0.015	

(1) THERMAL ASSAY

(2) 4.6% WT LOSS IN N_2 ATMOSPHERE AT 1500°F

34.8% INSOLUBLE RESIDUE IN 1.3 HCL

Table 12-30. DEPOSITS, RUN 12D

RUN 13

SEPTEMBER 28 - OCTOBER 9, 1973

CO_2 ACCEPTOR PROCESS GASIFICATION

PILOT PLANT

RAPID CITY, SOUTH DAKOTA

1 SUMMARY

The Run 13 series consisted of Run 13A (9/28/73 - 10/2/73) and Run 13B (10/5/73 - 10/9/73). Fully integrated plant operation was the objective for these runs. To achieve this goal, the following major changes to the startup procedure were made:

(1) Acceptor would be circulated continuously through the calcining period.

(2) The regenerator would be cooled to 1600°F should acceptor circulation cease.

(3) The gasifier boot heater would be operated at 1500°F.

Analysis of the Run 12 data suggested two new possible causes for regenerator deposit formation. These were: (1) The generation of tacky fines, and therefore, deposit formation due to undetected regenerator bed hot spots; and (2) The circulation from the gasifier of acceptor which contains a mixture of CaS and $CaSO_4$.

Startup procedure changes (1) and (2) were incorporated since circulating acceptor provides a significant regenerator heat sink by virtue of its sensible heat and calcination heat of reaction. Therefore, acceptor circulation should tend to eliminate bed hot spots.

Procedure (3) was included to minimize the amount of air required to maintain gasifier temperatures during the initial phases of startup. This in turn would minimize the amount of $CaSO_4$ formed from acceptor as it showers through the oxidizing zone near the air inlet. In addition, the 1500°F temperature of the boot recycle gas would promote the reduction of $CaSO_4$ to CaS.

The startup proceeded through the calcination stage in both Runs 13A and 13B. However, both runs were terminated shortly after calcination was completed. Run 13A ended after iron-nickel sulfide corrosion product plugged the recycle gas line to the gasifier boot. The plug formed and then broke causing a gas surge which destroyed the char-acceptor interface. Operations were discontinued since the recycle gas line to the gasifier boot remained restricted.

Run 13B was abandoned when two normally terminal conditions existed simultaneously. First, the calcined acceptor return line plugged near the regenerator inlet, and then the recycle gas line to the gasifier boot again plugged with iron-nickel sulfide material from the recycle gas heaters.

Fully-integrated, steady-state operation was not achieved in either run. However, the runs were successful since adherence to the new startup procedure resulted in the elimination of regenerator deposits.

Prior to Run 13A, a thermocouple probe was installed in the bottom of the regenerator. This probe consisted of a bundle of thermocouples and was designed to monitor temperatures in the area of the air distributor ring. The temperature measurements made during Run 13B demonstrated that generation of bottom hot spots was possible when the recycle gas contained excess amounts of CO. The high bottom bed temperature which occurred just prior to the Run 13B shutdown caused the probe to bend. The probe was straightened and support gussets added prior to the Run 14A.

The results of the Run 13 series led to the following run procedure changes:

(1) To reduce the amount of fines in the regenerator, natural gas will be used to initially calcine the acceptor bed. This should help keep the calcined acceptor return line clear.

(2) After demonstrating that acceptor circulation can be maintained following calcination, regenerator fuel char feed will be established (probably one to four hours after calcination).

(3) During and after calcination, the concentration of CO plus H_2 in the regenerator overhead gases will be limited to a maximum of 5 mole percent. This should reduce the possibility of bottom hot spots.

(4) To reduce corrosion of the gasifier boot heater, the outlet temperature will be limited to 600°F with char in the system.

2 TEST DATA

Run 13 data are presented graphically and/or tabularly at the end of this run report. These figures and tables include:

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3 SIGNIFICANT EVENTS AND OBSERVATIONS

3.1 HISTORY OF RUNS 13A AND 13B

(1) Purpose--Achieve fully-integrated, steady-state plant operation

(2) Accomplishments

a. Establishment of acceptor circulation between reactors with continuous acceptor showering through the char bed

b. Establishment of char combustion in regenerator

c. Calcination of the regenerator acceptor inventory

d. Operation without the formation of regenerator deposits

(3) Run Termination Causes

a. Run 13A--Loss of char-acceptor interface due to recycle gas surge into boot of gasifier followed by continued restriction of recycle gas line. Gas surge caused by breaking of iron-nickel sulfide deposit which had restricted the recycle gas line.

b. Run 13B

1. Plugging of the calcined acceptor return line, CD-206

2. Loss of gasifier recycle gas flow to boot due to a line restriction caused by accumulation of iron-nickel sulfide

(4) Other Problems

a. Plugging of the new regenerator flue gas quenching device

b. Continued sulfur attack in the gasifier recycle gas boot heater

3.2 CHRONOLOGY OF RUN 13A

Date	Time	Description
9/28	2000	Started pressure test, found several leaks
9/29	0230	Started to depressure
"	0430	System depressured
"	1230	Started pressure test
"	1530	System at 150 PSIG
"	1630	Recycle compressor started
"	1708	Slight power dip, nothing lost
"	1845	Heaters lit
"	2015	Started 4 hour refractory cure
9/30	0015	Cure complete, continuing heatup
"	0200	Steam admitted to gasifier side flow
"	1100	Regenerator heater outlets at 1400°F
"	1145	Gasifier heater outlets at 1600°F
"	1205	Started dolomite feed to gasifier
"	1250	Stopped dolomite feed, material bridged in boot
"	1255	Bridge broke, feeding resumed
"	1315	dPR-2001 lifted, stopped feed
"	1340	First batch transferred to regenerator
"	1730	Started dolomite to regenerator from F-206
"	2100	Posi-Seal valve above venturi will not open
"	2245	dPR-2075 lifted
10/1	0100	When transferring Batch NO. 9, could not transfer below 30 lines on dPR-2034
"	0730	dPR-2026 started to indicate sealing of calcined acceptor return line, dPR-2077 lifted
"	0830	Added air to regenerator to improve fluidization
10/1	1215	Established good solids circulation
"	1420	Completed solids circulation tests
"	1600	Dumped boot (500 LBS) to F-213 to get rid of excessive fines
"	1615	Line from gasifier knock-out pot to foul water stripper plugged
"	1600-1745	Circulating dolomite
"	1800	Air removed from regenerator
"	1900	Char feed to gasifier
"	2030	Added air to regenerator, could not get enough flow from recycle compressors to expand bed as desired
10/2	0045	dPR-2032 lifted
"	0100	Added 10,000 SCFH air to gasifier, removed 10,000 SCFH steam. All inert gas makeup out of gasifier
"	0245	Had problems with plugged dP's, lost interface
"	1430	Interface back
"	1500	Resumed char feed
"	1615	B-201-IA back to 1500°F

Date	Time	Description
10/2	1940	Char bed inventory complete, started reducing heater temperatures in preparation for char combustion
"	2300	Pressure at gasifier "tee" at 205 PSIG, losing boot flow
"	2310	Started circulation to try to reduce pressure at "tee," pressure increased to 215 PSIG
"	2330	Upset in gasifier, apparently due to low flow. Circulation stopped, also, problems with dP's due to high pressure
10/3	0000	Maximum boot flow 20,000 SCFH with 220 PSIG at "tee"
"	0235	Increased natural gas flow to regenerator, decreased air to gasifier to 5,000 SCFH, increased steam to 40,000 SCFH
"	0310	B-203 and B-204 heaters lowered to 800^{o}F
"	0550	Started solids circulation
"	0700	Lost interface
"	0830	Regained interface
"	0840	Resumed solids circulation
"	0845	Started natural gas and air to regenerator
"	1030	Started char feed to regenerator, feed rate erratic
"	1405	Established reliable char feed
"	1600	Increasing boot heater to 1550^{o}F and air heater to 1000^{o}F
"	1735	Lost interface due to surge of flow, plug at tee partially cleared. Lost seal at TCV-2030
"	1748	Power dip, lost one recycle compressor, CO_2 compressor, air compressor and inert gas compressor. Jumpered low flow switch on boot heaters, trying to reestablish interface.
"	2020	Started cutting temperatures, taking air out of gasifier and regenerator
"	2040	Sudden gas surge into gasifier as plug broke at tee section
"	2050	Lost boiler, almost lost all steam to side flow. Put recycle back in
"	2120	Boiler back on, steam back to side flow
"	2130	Dumping gasifier to F-213
"	2225	Steam out of side flow, replaced with recycle gas
"	2300	Heaters shut down
"	2330	Transferred through TCV-2030 for 5 minutes. Put steam to side flow of gasifier, and put all recycle to boot to try to break plug. Pressure went to 205 PSIG but plug would not break. Could not relight B-201B heaters
"	2400	Steam out of gasifier, continued shutdown

3.3 CHRONOLOGY OF RUN 13B

Date	Time	Description
10/5	1600	Started pressure test
"	1845	System at 150 PSIG
"	1940	Started recycle compressors, having trouble with dPR-2028 and dPR-2029
"	2010	Shut down compressors, XCV-2010 would not stroke completely. Cleared with blast line at valve
"	2020	Restarted compressors, attempted to clear char lift line, CO-204
"	2040	Shut down recycle compressors
"	2050	Started depressuring system
10/6	0430	Started pressure test
"	0700	System at 150 PSIG
"	0810	Started recycle compressors, bottom of engager pot plugged
"	0845	Cleared plug by blowing back towards control valve, FCV-2014
"	0900	Heaters lit
"	1215	Plug at engager pot
"	1310	Depressuring system to clear engager pot
"	1715	Started pressure test
"	1955	Started recycle compressors
"	2025	Lit heaters
10/7	0315	Steam to gasifier side flow
"	0700	Partial plug in lift line from engager pot
"	0830	Cooling system
"	1110	Compressors shut down
"	1300	System depressured to clear line
"	1505	Started pressure test
"	1700	Started recycle compressors, lit heaters
"	1840	Steam to side of gasifier
10/8	0300	Reactors up to temperature
"	0330	Started dolomite addition
"	0520	Transferring first batch to regenerator
"	2030	Dolomite inventory completed, started circulation tests
"	2042	Lost seal at TCV-2030
"	2105	Regained seal, resuming tests
"	2115	Sudden system shakeup, plug in line CO-204, cut air out of regenerator
10/9	0000	Cleared plug
"	0020	Started circulation test
"	0200	Started char addition
"	0930	10,000 SCFH air added to gasifier side flow and 10,000 SCFH steam removed
"	1125	B-203 and B-204 heaters at 1000^{o}F
"	1130	Natural gas to regenerator
"	1205	Started acceptor circulation

Date	Time	Description
"	1220	Power dip
"	1230	Power dip
"	1315	Started burning char in regenerator
"	1335	Recycle out of B-203 heater, raising temperature to $1400^{o}F$
"	1415	Power failure for 3 to 4 seconds, lost one compressor from each set, CO_2 compressor, air compressor, and various pumps. Everything back okay.
"	1645	Lost seal on TCV-2030, inlet to CD-206 plugged
"	1715	Boot flow restricted, pressure at "tee" 210 PSIG
"	1755	Cooling regenerator, removing air
"	1808	All air and char out of regenerator
"	1815	Cooling heaters, boot heaters off on low flow
"	2230	Steam out of gasifier side
10/10	0430	Depressuring system

4 DISCUSSION AND RESULTS

4.1 BACKGROUND

The objective of the Run 13 series was to obtain fully-integrated plant operation while circulating calcined acceptor. This goal was never achieved during the 12 series runs because of the formation of regenerator deposits and the plugging of the calcined acceptor return line. However, the Run 12 data did provide insight into the causes of the deposits and the line plugging problem.

As was the usual case, all the Run 12 deposits appeared to be composed of agglomerated fines. Additionally, three types of line plugs were discovered. These were: (1) plugs caused by backflushing of gasifier steam up the calcined acceptor standleg; (2) plugs caused by bridging of tacky fines aggregate mixtures; and (3) plugs caused by pipe scale deposits which were very much like the deposits found in the regenerator. Except for the plug caused by steam backflushing, the line plugging and deposit formation problems seem to have a common origin, the formation of tacky fines in the regenerator. A review of the run conditions and the analytical results suggested two new possible mechanisms for deposit formation. These are the generation of tacky fines due to undetected hot spots, and formation of transient liquid due to the presence of $CaS \cdot CaSO_4$ mixtures in the incoming spent acceptor from the gasifier.

To avoid conditions favorable to deposit and plug formation, the following changes were made to the startup procedure for Run 13:

(1) Acceptor would be circulated continuously after calcination is initiated. The circulating acceptor provides a substantial heat sink in the regenerator bed and thereby minimize the chances for hot spot formation.

(2) The regenerator would be cooled immediately to $1600^{\circ}F$ should acceptor circulation cease. This will prevent deposits from occurring after the heat sink provided by the circulating acceptor is removed.

(3) The gasifier boot heater would be operated at $1500^{\circ}F$ in order to:

   a. Reduce the amount of air required to maintain the char bed temperature during the early stages of startup (this would reduce the amount of $CaSO_4$ formed as the acceptor showered through the oxidizing zone).

   b. Provide conditions favorable for the reduction of $CaSO_4$ to CaS.

(4) To increase the chances for fines removal from the regenerator bed, improve the reliability of bed height indication and reduce attrition, efforts will be made to control the regenerator bed expansion at 75 percent. The bed level will be maintained at 22 feet, two feet above the acceptor withdrawal.

4.2 ACCOMPLISHMENTS

The regenerator acceptor inventory was calcined during both Run 13A and Run 13B. This is shown in Figures 13-1 and 13-2 in which the actual regenerator CO_2 partial pressure is compared with the calcium carbonate CO_2 vapor pressure. For typical process conditions, Table 13-1 should be consulted. As shown by Figure 13-1, the acceptor inventory began to recarbonate almost immediately in Run 13A after calcination was completed. This was due to cooling the regenerator as the system was shut down. The shutdown resulted when the plug in the gasifier boot gas inlet line could not be cleared.

Although fully-integrated, steady-state plant operation with the circulation of calcined acceptor was never achieved during either run, the runs did demonstrate that regenerator deposits could be avoided. No regenerator wall deposits were found after either run. The Run 13A regenerator dump material did not contain any ball agglomerations, and only a few (1/4-inch diameter) balls were found in Run 13B dump material. These probably would not have formed had the regenerator been cooled immediately to 1600°F after acceptor circulation ceased. The regenerator was not cooled until one hour and 15 minutes after CD-206 plugged because hope was that the line would be cleared quickly.

Undetected hot spots in the bottom of the regenerator were suspected to occasionally exist. Since hot spots probably contributed to the formation of regenerator deposits, detection and elimination of them is important. Therefore, prior to Run 13 a temperature probe which contained seven thermocouples was installed in the bottom of the regenerator. This allowed temperature monitoring from a bottom point at the air distributor ring to 42 inches above the ring at 7-inch increments. Proof that bottom hot spots could exist was obtained during Run 13B. As shown in Figure 13-3, a very large temperature difference (138°F) did exist between two bed elevations (points 20 and 22) which were only 14 inches apart. Point 20 is 7 inches above the air ring while point 22 is 21 inches above. The temperature difference was caused by excessively high concentrations of CO in the recycle gases. This CO reacted with the combustion air to produce a high temperature gradient. The bent temperature probe found after Run 13B provides additional evidence that a localized flame front existed. Bending occurred at the point at which air impinged upon the probe.

4.3 PROBLEMS

Two major problems were common to both Runs 13A and 13B. These were sulfur corrosion in the gasifier boot heater, B-201-IA, and plugging of the new flue gas quenching device. Plugging of the calcined acceptor return line also occurred during Run 13B.

In previous runs the sulfur in the gasifier recycle gas corroded the recycle gas heater tubes. Corrosion was particularly severe in the Incoloy 800 section of the B-201-IA heater. To reduce the rate of corrosion in this heater, the outlet temperature was limited to 600°F when char was in the system during the Run 12 series. However, during these runs the heater continued to plug. Although the heater coil was mechanically cleaned, some corrosion scale remained in the tubes and sloughed from the walls.

Since heat transfer across the char-acceptor interface was quite poor, the low heater outlet temperature made acceptor showering more difficult. This was due to the abrupt change in gas velocity as the boot fluidizing gas flowed from a zone of low temperature at 700°-800°F into the char bed at 1450°F.

Additionally, chemical analyses of the spent acceptor revealed the presence of both CaS and $CaSO_4$. Therefore, the low boot temperature may have contributed to the formation of regenerator deposits by eliminating conditions favorable for the reduction of $CaSO_4$ and CaS. Oxidation of CaS as the acceptor showered through the oxidizing zone in the gasifier transition section was probably the source of the $CaSO_4$.

Since new coils for the heater had been ordered, the decision was made to operate the heater at 1500°F for the Run 13 test series and sacrifice the coil if necessary. This operation resulted in further sulfur corrosion. In both runs the corrosion product, iron-nickel sulfide, was carried out of the heater as a liquid, collected and solidified in the tee pipe section ahead of the gasifier boot inlet. The resulting plugs so severely restricted the gas flow that fluidization in the gasifier boot could not be maintained. Ultimately, the solution to the heater problem will be to replace the coil with a new one and install a zinc oxide sulfur removal system.

As in Run 12 chemical analysis of the spent acceptor from the gasifier showed the presence of $CaS \cdot CaSO_4$ mixtures (see Tables 13-4, 13-5 and 13-6). No definite conclusions concerning the presence of $CaSO_4$ can be made since the hot samples may have contacted air when they were taken.

To improve the operation of the regenerator quench system, a mechanical flue gas quenching device was installed in parallel with the quench tower venturi. The major components of the device are shown in Figures 13-4 and 13-5. The unit consists of a three-inch pipe in which a shaft with metal spikes is rotated. Periodically, a pneumatic

ram is actuated to shake the entire stirring mechanism. The unit was installed in a vertical position so that the gas entered at the top. The regenerator flue gases traveling down through the device are contacted with water. Since conditions are quite turbulent, good gas-liquid contact is achieved. Any acceptor and char ash fines contained in the gases are wetted and removed. The purpose of the stirrer is to keep the pipe walls clean while the periodic hammering of the stirrer shaft is to jar loose solids accumulations on the shaft and spikes.

Shortly after the device was put in service, the pressure drop across the flue gas quencher exceeded 15 PSI and at times was greater than 30 PSI. Following both shutdowns, inspection of the device showed that a deposit made up of acceptor fines had restricted the flow along a 2-foot section of the shaft below the water inlets. However, the pipe walls and the downstream piping to the quench tower were clean.

Plugging of the calcined acceptor return line continued to be a problem. During Run 13B the line plugged at the regenerator outlet. This plug was difficult to remove but broke into individual particles which were covered with char fines. Chemical analysis of the plug (see Table 13-13) show it to be primarily acceptor. Apparently, the circulating acceptor which contained a large amount of fines bridged at the line inlet. When the line ran dry above TCV-2030, gasifier steam back flushed up the line further solidifying the plug. The steam back flushing would also account for the char coating on the acceptor particles.

5 FUTURE PLANS

Based on the results of the Run 13 series, the following modifications will be made to the Run 14 startup procedure:

(1) To reduce the presence of fines in the regenerator bed, natural gas will be used for the initial acceptor calcination. This should improve the reliability of acceptor circulation through CD-206.

(2) To reduce the probability of regenerator bottom hot spots, the CO and H_2 in the regenerator recycle gases will be limited to a 5 percent maximum.

(3) To reduce corrosion of the gasifier boot heater, the outlet temperature will be limited to 600°F when char is in the system.

(4) One to four fours after calcination, char feed to the regenerator will be established. This should be sufficient time to demonstrate that acceptor circulation can be maintained reliably.

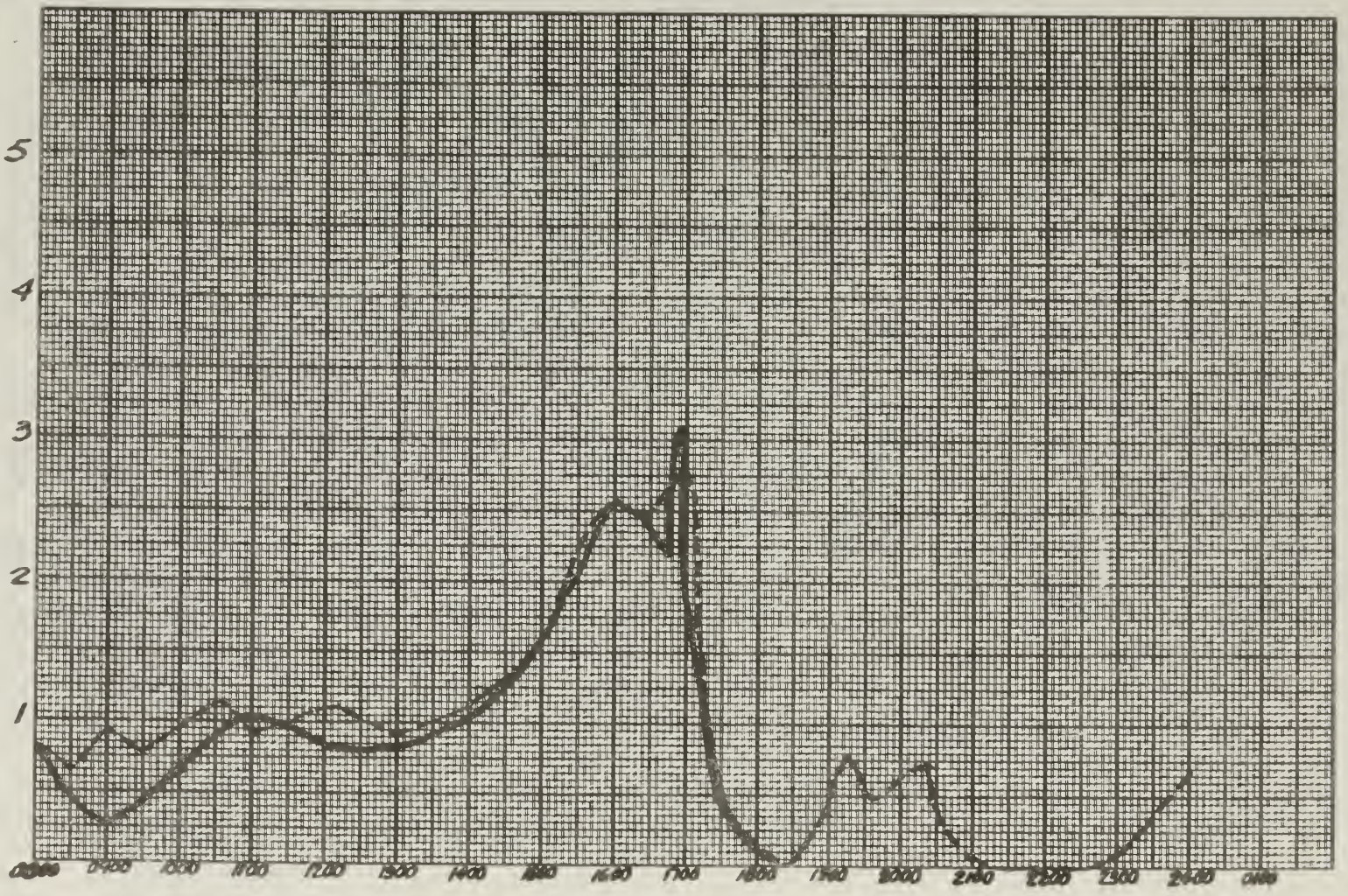

Figure 13-1. CALCINATION CURVE, RUN 13A

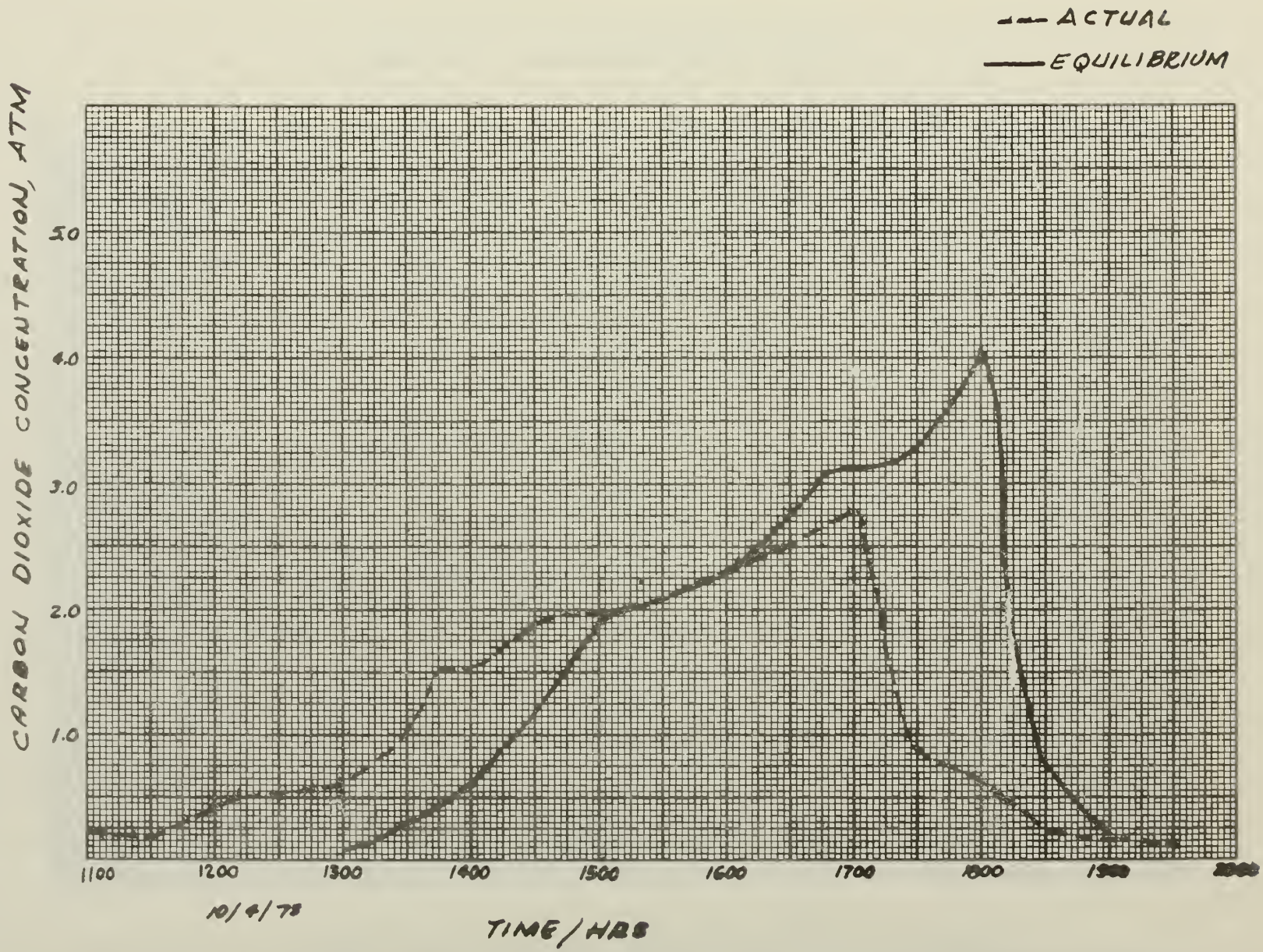

Figure 13-2. CALCINATION CURVE, RUN 13B

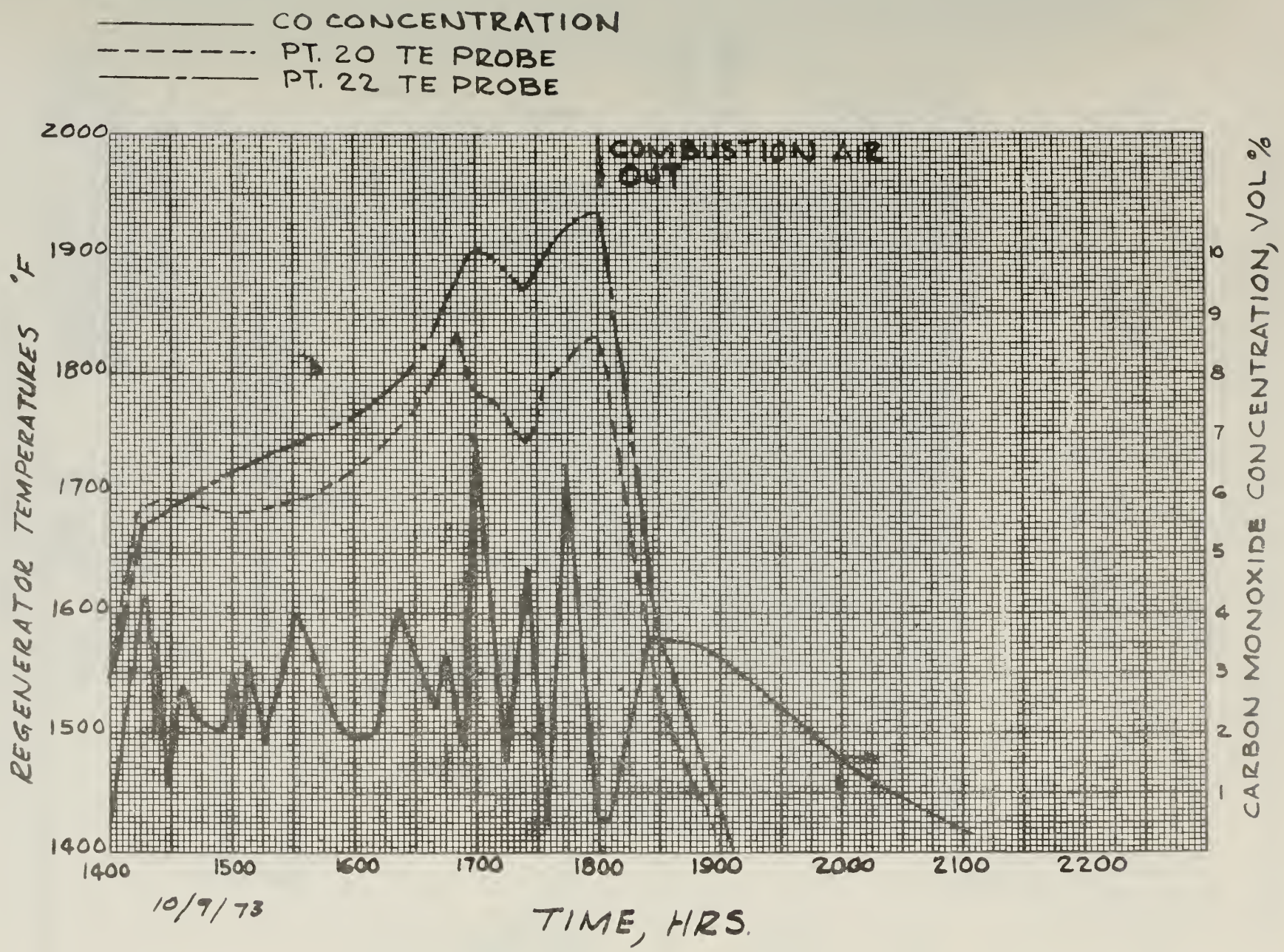

Figure 13-3. REGENERATOR BED TEMPERATURES AND CARBON MONOXIDE CONCENTRATION, RUN 13 B

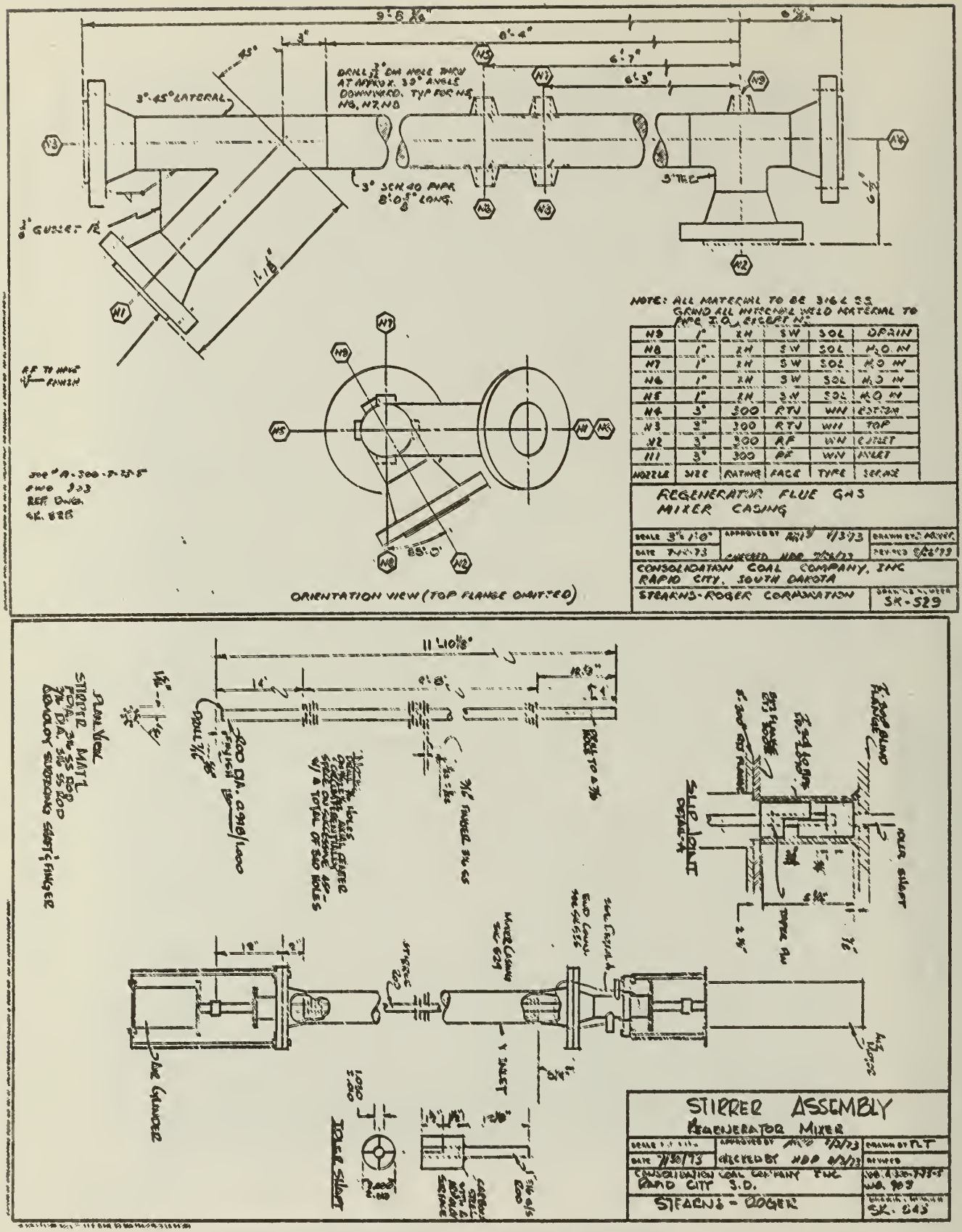

Figure 13-4. REGENERATOR FLUE GAS QUENCHER

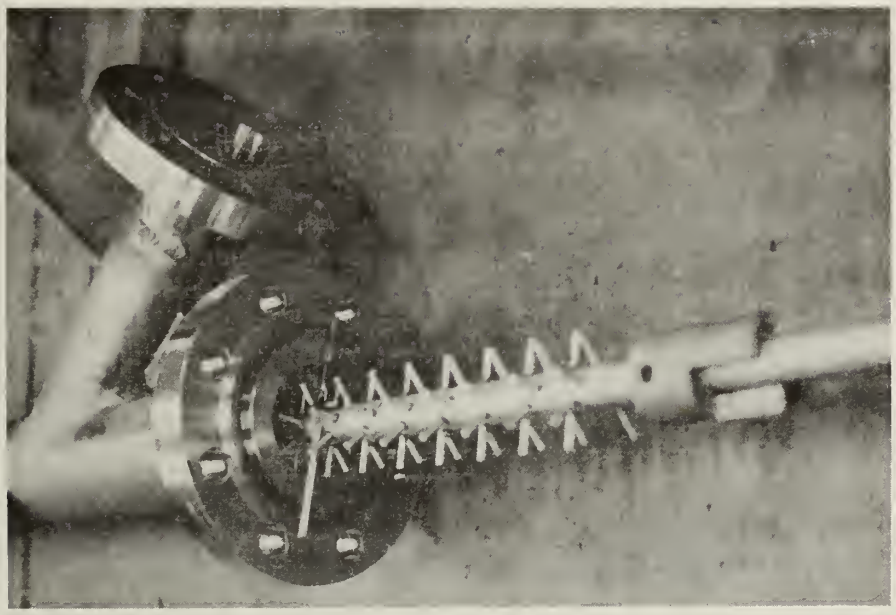

Figure 13-5. ASSEMBLY OF FLUE GAS QUENCHER

	Run 13A			Run 13B		
Date	10/3	10/3	10/3	10/9	10/9	10/9
Time	1300	1500	1700	1300	1700	1800
Regenerator						
Steam Make, Lb/Hr	330	350	250	280	300	300
Dolomite Lift, SCFH	104,000	86,600	80,600	84,000	90,200	83,500
Char Lift, SCFH	9,200	6,890	7,020	7,240	7,240	7,330
Recycle - Air Line, SCFH	0	0	23,400	14,400	0	0
Air, SCFH	31,700	53,700	70,100	25,200	37,200	18,600
Total	144,900	147,190	181,120	130,840	134,640	109,430
Vent Rate, SCFH	32,000	62,700	66,800	22,000	34,100	33,700
Average Bed Temperature, °F	1630	1705	1740	1395	1835	1830
Bed Velocity, Ft/Sec	2.46	2.58	3.23	1.97	2.50	2.03
Bed Density, Lb/Ft^3	62-78	57-82	50-63	67-82	47-65	51-65
Gasifier						
Steam Make, Lb/Hr	25	25	25	0	0	0
Boot, SCFH	23,000	26,900	9,860	27,900	21,400	20,500
Steam, SCFH	49,300	54,200	61,700	35,400	35,300	35,400
Air, SCFH	13,100	11,200	9,710	11,200	10,500	10,500
Total	85,400	92,300	81,270	74,500	67,200	66,400
Vent Rate, SCFH	25,600	24,200	27,200	21,900	24,700	20,100
Boot Temperature, °F	1298	1350	1360	1325	1435	1330
Bed Temperature, °F	1427	1390	1420	1360	1400	1380
Boot Velocity, Ft/Sec	1.09	1.31	0.484	1.34	1.10	0.991
Bed Velocity, Ft/Sec	0.881	0.933	0.835	0.741	0.683	0.667
Boot Density, Lb/Ft^3	(2)	(2)	(2)	67	62	55
Bed Density, Lb/Ft^3	37	38	43	37	37	36
Gross Btu, Btu/SCF(1)	178	192	200	168	157	224

(1) N_2 included
(2) Instrument out of service

Table 13-1. REGENERATOR - GASIFIER DATA, CALCINATION PERIODS, RUN 13

Run 13A

Date 9/30 - 10/3

Screen Size Tyler Mesh	Dolomite 6 X 16[1] Wt %	Dolomite 6 X 9[2] Wt %	Char Screen Size Tyler Mesh	Char Wt %
+4	Tr	0.4	+6	-
4 X 6	0.2	3.6	6 X 8	1.3
6 X 8	18.7	30.1	8 X 10	3.0
8 X 9	17.9	28.3	10 X 14	8.6
9 X 10	16.1	22.0	14 X 20	11.7
10 X 12	12.4	11.4	20 X 28	14.1
12 X 14	13.1	3.6	28 X 35	13.3
14 X 16	9.6	0.5	35 X 48	13.0
16 X 20	8.5	0.1	48 X 65	9.5
20 X 24	2.6	Tr	65 X 100	7.3
24 X 28	0.7	Tr	100 X 200	9.8
-28	0.2	0.1	-200	9.4
Particle Density, lb/cu ft	167[3]			75.5

Ultimate Analysis, Wt %

	Char
C	85.30
H	2.19
N	0.61
O	(7.19)
S	1.79
Ash (SO_3 Free)	14.79

Table 13-2. FEEDSTOCK COMPOSITES, RUN 13A (Sheet 1 of 2)

Run 13A

Date 9/30 - 10/3

	Dolomite		Char Ash
	6 X 16[1]	6 X 9[2]	
			Wt %
Elemental Analysis, Wt %			
SiO_2	5.29[3]		34.74
CaO	56.24		33.12
MgO	35.06		10.58
Na_2O	0.04		1.61
Fe_2O_3	0.88		7.26
Al_2O_3	1.70		11.92
P_2O_5	0		0.04
TiO_2	0		0.81
K_2O	0.08		0.46
SO_3	0.62		-
Sulfide	0.002		0.04

(1) Composite of three screens
(2) Composite of two screens

(3) Composite of all feed acceptor

( ) Calculated by difference

Table 13-2. FEEDSTOCK COMPOSITES, RUN 13A (Sheet 2 of 2)

Run 13B

Date 10/8 - 10/10

	Dolomite			Char
Screen Size Tyler Mesh	6 X 16 Wt %	6 X 9 Wt %	Screen Size Tyler Mesh	Wt %
+4	0	0.8	+6	0
4 X 6	0.1	3.8	6 X 8	2.4
6 X 8	19.0	35.8	8 X 10	5.7
8 X 9	19.2	23.8	10 X 14	13.1
9 X 10	16.9	18.8	14 X 20	11.4
10 X 12	12.6	10.4	20 X 28	15.8
12 X 14	12.2	4.4	28 X 35	11.8
14 X 16	8.6	1.1	35 X 48	9.8
16 X 20	7.3	0.4	48 X 65	6.6
20 X 24	2.6	0.1	65 X 100	6.8
24 X 28	0.9	0.2	100 X 200	5.5
-28	0.6	0.3	-200	6.2

Particle Density, lb/cu ft	167	
Calcine Weight Loss, percent	45.36	
Ultimate Analysis, Wt %		
C		66.64
H		1.56
N		0.99
O		-
S		1.47
H_2O		0.9
Ash		24.91
Ash Analysis, Wt %		
SiO_2	5.40	25.92
CaO	55.36	33.41
MgO	36.36	8.08

Table 13-3. FEEDSTOCK COMPOSITES, RUN 13B (Sheet 1 of 2)

Run 13B

Date 10/8 - 10/10

	Dolomite		Char Ash
	6 X 16	6 X 9	
Elemental Analysis, Wt %			
Na_2O	0.13		1.34
Fe_2O_3	0.70		4.87
Al_2O_3	1.66		9.61
P_2O_5	0.01		0.01
TiO_2	0		0.31
K_2O	0.14		0.45
SO_3	0.78		16.79
Sulfide	0.005		0.02

Table 13-3. FEEDSTOCK COMPOSITES, RUN 13B (Sheet 2 of 2)

Run 13A

	Calcined Acceptor Return					
Date	10/1[(1)]	10/1[(1)]	10/1[(1)]	10/3	10/3	10/3
Time	1215	1500	1740	0800	1200	1615
Screen Size Tyler Mesh	← Weight Percent →					
+4	0	0	0	0	0	0
4 X 6	0.2	0.1	0.1	0.5	0.1	0.1
6 X 8	21.5	39.6	26.7	22.5	23.9	26.7
8 X 9	18.0	27.3	23.8	19.6	22.3	25.0
9 X 10	15.2	16.4	18.7	17.4	18.5	18.7
10 X 12	11.5	7.8	10.4	11.4	11.4	10.3
12 X 14	10.8	5.1	7.7	9.6	8.9	7.1
14 X 16	7.6	2.1	4.6	6.0	5.1	3.4
16 X 20	6.9	1.2	3.6	5.5	3.7	2.4
20 X 24	3.2	0.3	1.7	2.9	1.7	0.8
24 X 28	1.9	Tr	0.8	2.0	1.1	0.5
-28	3.2	0.1	1.9	2.7	3.4	4.9
Particle Density, lb/cu ft						112.8
Activity					0.9	0.6
Elemental Analysis, Wt %						
SiO_2	5.68	5.54	5.46	5.60	5.33	5.13
CaO						55.38
MgO						35.40
Na_2O						0.06
Fe_2O_3						0.60
Al_2O_3						1.70
P_2O_5						0.02
TiO_2						0.19
K_2O						0.05
SO_3	0.51	0.39	0.42	0.56	0.72	1.16
Sulfide	0.015	0.015	0.015	0.124	0.14	0.242

(1) Before establishment of char bed

Table 13-4. CIRCULATED ACCEPTOR, CALCINED ACCEPTOR RETURN, RUN 13A

Run 13A

	Recarbonated Acceptor Return					
Date	10/1[1]	10/1[1]	10/1[1]	10/3	10/3	10/3
Time	1200	1500	1740	0850	1245	1630
Screen Size Tyler Mesh	← Weight Percent →					
+4	0	0	0	0	0	0
4 X 6	0.1	Tr	0.1	0.2	0	0
6 X 8	16.7	16.5	17.9	19.6	19.3	16.4
8 X 9	13.8	15.2	16.1	17.9	19.1	19.6
9 X 10	11.2	12.4	13.9	14.3	16.2	17.4
10 X 12	8.5	9.1	10.9	9.6	11.4	12.7
12 X 14	6.5	9.6	11.6	8.9	10.2	10.6
14 X 16	6.5	7.0	8.6	6.0	7.3	6.6
16 X 20	6.5	7.5	8.4	5.5	6.7	5.9
20 X 24	3.4	3.7	4.3	3.0	3.9	3.6
24 X 28	2.7	3.1	2.9	2.7	3.2	3.6
-28	(22.4)	(15.6)	5.3	(12.1)	2.6	3.5
Particle Density, lb/cu ft	137				120	120
Activity	1.0				0.8	0.7
Elemental Analysis, Wt %						
SiO_2						6.24
CaO						54.95
MgO						33.50
Na_2O						0.11
Fe_2O_3						0.80
Al_2O_3						1.92
P_2O_5						0.02
TiO_2						0.28
K_2O						0.10
SO_3	0.85	0.68	0.37	1.30	0.93	2.19
Sulfide	0.030	0.030	0.015	0.017	0.081	

( )Calculated by difference

Table 13-5. CIRCULATED ACCEPTOR (CONTINUED), RECARBONATED ACCEPTOR RETURN, RUN 13A

Run 13B

	Calcined Acceptor Return			Recarbonated Acceptor Return		
Date	10/9	19/9	10/9	10/9	10/9	10/9
Time	1230	1709	1745	1245	1400	1709
Screen Size	← Weight Percent →					
Tyler Mesh						
+4	0	0	0.1	0	0	0.2
4 X 6	0	1.0	0.7	0.2	0.8	0.7
6 X 8	18.3	25.0	14.3	25.5	23.7	16.8
8 X 9	19.3	24.9	15.4	24.5	21.6	18.5
9 X 10	17.3	19.4	16.6	19.5	18.5	17.6
10 X 12	12.3	10.5	12.2	12.1	12.3	12.9
12 X 14	11.9	7.8	11.8	9.6	10.5	11.4
14 X 16	8.0	3.9	7.6	5.2	6.4	8.4
16 X 20	6.4	2.3	6.1	2.7	4.1	6.4
20 X 24	2.7	0.9	3.0	0.6	1.4	5.4
24 X 28	1.6	0.5	1.9	0.1	0.5	1.2
-28	2.1	3.8	10.3	0.1	0.2	0.5
Particle Density, lb/cu ft				125		122.5
Elemental Analysis, Wt %						
SiO_2	5.76	5.87	6.42			5.20
CaO			55.85			53.52
MgO			35.35			37.44
Na_2O			0.10			0.05
Fe_2O_3			0.76			0.74
Al_2O_3			2.24			1.99
P_2O_5			0.01			0.01
TiO_2			0			0
K_2O			0.14			0.07
SO_3	0.58	0.73	0.77	2.22	0.30	1.57
Sulfide	0.042	0.14	0.13	0.21	0.15	0.25

Table 13-6. CIRCULATED ACCEPTOR, RUN 13B

Run 13A

Date	10/3	10/3	10/3
Time	1010	1245	1400
Screen Size	←Weight Percent→		
Tyler Mesh			
+6	0	0	0
6 X 8	2.1	5.0	5.5
8 X 10	5.1	8.6	8.3
10 X 14	9.5	13.6	13.4
14 X 20	14.1	16.3	14.8
20 X 28	16.1	17.9	17.6
28 X 35	13.3	14.4	15.3
35 X 48	11.1	11.3	12.2
48 X 65	8.2	6.7	6.9
65 X 100	6.8	3.8	3.8
100 X 200	6.5	2.1	1.9
-200	7.1	0.3	0.3
Particle Density, lb/cu ft	50	51	47
Ultimate Analysis, Wt %			
C		72.42	73.17
H		2.67	1.12
N		-	-
S		0.32	0.63
H_2O		0.75	0
Ash		21.09	21.47
Elemental Analysis, Wt %			
SiO_2		21.96	22.94
CaO		40.87	37.84
MgO		12.97	11.99
Na_2O		2.21	2.05
Fe_2O_3		1.93	1.95
Al_2O_3		16.93	13.66
P_2O_5		0.04	0.04
TiO_2		0.52	4.30
K_2O		1.19	0.98
SO_3		1.58	3.76
Sulfide		0.02	0.02

Table 13-7. REGENERATOR FEED CHAR, RUN 13A

Run 13B

Date	10/9	10/9	10/9
Time	1330	1400	1709
Screen Size Tyler Mesh	← Weight Percent →		
+6	0	0	0
6 X 8	3.5	2.9	6.8
8 X 10	6.3	5.2	10.8
10 X 14	10.2	10.7	14.7
14 X 20	13.4	15.0	16.1
20 X 28	16.4	17.4	17.2
28 X 35	16.6	15.1	13.3
35 X 48	15.5	13.8	10.1
48 X 65	9.6	9.7	5.9
65 X 100	5.3	6.2	3.2
100 X 200	2.7	3.7	1.7
-200	0.2	0.3	0.1
Particle Density, lb/cu ft	66	55	
Ultimate Analysis, Wt %			
C		74.56	73.74
H		1.19	0.99
N		0.34	-
S		0.20	0.26
H_2O		0.28	0.2
Ash		19.91	20.98
Ash Analysis, Wt%			
SiO_2		24.70	24.49
CaO		38.22	39.01
MgO		12.66	12.70
Na_2O		2.14	2.34
Fe_2O_3		3.14	2.18
Al_2O_3		16.31	14.93
P_2O_5		0.04	0.01
TiO_2		0.82	0.25
K_2O		2.09	1.20
SO_3		1.22	2.81
Sulfide		0.01	0.02

Table 13-8. REGENERATOR FEED CHAR, RUN 13B

Run 13A

Date	10/2	10/2	10/3	10/3	10/3
Time	0200	2035	0330	1235	1680
Screen Size Tyler Mesh			Weight Percent		
+35	2.0	0.3	0.1	9.2	1.3
35 X 48	0.8	0.2	0.3	6.9	0.5
48 X 65	4.4	1.7	1.3	5.5	1.3
65 X 100	9.2	4.0	3.7	5.3	3.1
100 X 200	11.2	8.0	10.4	11.4	13.7
200 X 325	13.4	17.6	23.9	50.2	64.5
-325	59.0	68.2	60.3	11.5	15.6
Chemical Analysis, Wt %					
CO_2	32.5	31.4	28.8		25.24
C	1.8	0.2	0.3		0.66
Ash (SO_3 Free)	64.9	67.2	69.4		72.0
Ash Analysis, Wt %					
SiO_2	5.41	5.50	8.91		6.82
CaO					54.60
MgO					32.96
Na_2O	0.12	0.12	0.33		0.16
Fe_2O_3					1.13
Al_2O_3					2.45
P_2O_5					0.02
TiO_2					0.68
K_2O					0.29
SO_3	1.18	1.79	2.17		1.20
Sulfide					0.05

Table 13-9. ASH AND ATTRITED ACCEPTOR, RUN 13A

Run 13B

Date	10/9	10/9
Time	0345	1100
Screen Size Tyler Mesh	Weight Percent	
+35	0.4	0.6
35 X 48	0.3	0.1
48 X 65	1.6	1.2
65 X 100	6.9	4.7
100 X 200	18.0	10.1
200 X 325	32.6	24.2
-325	40.1	59.1
Chemical Analysis, Wt %		
CO	32.10	-
C	1.7	-
Ash	66.20	69.13
Elemental Analysis, Wt %		
SiO_2	5.39	5.42
Na_2O	0.48	0.05
SO_3	1.06	4.41

Other components not determined

Table 13-10. ASH AND ATTRITED ACCEPTOR, RUN 13B

Run 13A

Date 10/4

Regenerator Dump				Gasifier Dump					
	Top	Middle	Bottom		Top				Bottom
Screen Size Tyler Mesh	Weight Percent			Screen Size Tyler Mesh	← Weight Percent →				
+4	0	0	0.2						
4 X 6	0.7	0.2	0.5	+8	2.6	3.0	8.4	2.9	11.9
6 X 8	13.9	19.8	21.5	8 X 10	5.8	5.7	13.8	6.9	22.8
8 X 9	16.1	20.4	22.5	10 X 14	8.8	9.2	13.5	13.0	23.6
9 X 10	17.7	18.3	18.4	14 X 20	11.9	12.1	11.8	14.4	13.4
10 X 12	12.5	12.1	11.9	20 X 28	17.1	16.7	14.1	17.0	10.0
12 X 14	9.1	9.0	8.6	28 X 35	17.7	16.5	13.0	15.5	6.9
14 X 16	5.3	4.6	4.2	35 X 48	15.7	15.2	11.0	13.5	5.0
16 X 20	4.4	4.0	3.3	48 X 65	9.9	9.8	6.8	8.2	3.0
20 X 24	2.3	2.0	1.8	65 X 100	6.0	6.4	4.2	4.9	1.8
24 X 28	1.9	1.7	1.4	100 X 200	3.9	4.6	3.0	3.4	1.3
-28	16.1	7.8	5.7	-200	0.6	0.8	0.4	0.5	0.3
Particle Density, lb/cu ft	120	117	121		48.1	48.3	50.0	48.4	48.7
Char, percent					70	75	55	70	35
Ultimate Analysis, Wt %(1)									
C					76.10	75.20	75.70	77.75	74.67
H					0.98	0.98	0.97	1.20	1.01
S					0.25	0.28	0.28	0.30	0.31
Ash (SO_3 Free)					18.31	18.20	18.57	19.80	19.76

Table 13-11. SOLIDS REMOVED AT SHUTDOWN, RUN 13A (Sheet 1 of 2)

Run 13A

Date 10/4

	Regenerator Dump			Gasifier Dump				
	Top	Middle	Bottom	Top				Bottom
Elemental Analysis, Wt %(1)								
SiO_2	7.67	6.37	6.08	23.39	22.34	24.95	24.03	24.49
CaO	51.35	52.32	53.49	42.77	41.06	40.62	40.91	41.25
MgO	35.11	35.43	35.22	13.26	12.79	12.67	12.72	13.77
Na_2O	0.10	0.93	0.10	3.01	2.80	2.74	2.41	2.81
Fe_2O_3	0.82	0.77	0.77	2.10	2.32	2.56	2.69	2.46
Al_2O_3	3.05	2.39	2.39	14.46	14.29	14.79	14.79	13.64
P_2O_5	0.01	0.01	0.01	0.05	0.04	0.04	0.04	0.04
TiO_2	0.09	0.10	0.10	0.52	0.53	0.52	0.51	0.50
K_2O	0.18	0.18	0.15	1.05	1.00	2.32	1.07	1.04
SO_3	1.74	1.69	1.68					
SO_3								
SO_3, as S				0.15	0.16	0.19	0.19	0.18
Sulfide	0.30	0.40	0.30					

(1) Analysis of "char" elutriated from sample

Table 13-11. SOLIDS REMOVED AT SHUTDOWN, RUN 13A (Sheet 2 of 2)

Run 13B

Date 10/10

Regenerator Dump[1]			Gasifier Dump[2]			
	Top	Bottom		Top	Middle	Bottom
Screen Size Tyler Mesh	Weight Percent		Screen Size Tyler Mesh	← Weight Percent →		
+4	1.7	0.7	+6	0	0	0	0
4 X 6	2.9	2.3	6 X 8	1.1	1.0	1.5	7.0
6 X 8	21.6	20.5	8 X 10	2.9	2.8	4.2	15.8
8 X 9	15.4	15.4	10 X 14	8.1	7.0	9.5	19.7
9 X 10	13.7	13.8	14 X 20	13.2	13.2	13.8	14.9
10 X 12	9.0	8.9	20 X 28	17.6	19.6	17.8	14.9
12 X 14	7.4	8.3	28 X 35	15.9	18.9	16.6	11.4
14 X 16	4.4	5.2	35 X 48	14.4	16.4	14.9	8.3
16 X 20	3.5	4.1	48 X 65	10.3	10.5	10.3	4.4
20 X 24	1.7	1.9	65 X 100	7.6	6.3	6.7	2.3
24 X 28	1.3	1.7	100 X 200	7.0	3.8	4.4	1.2
-28	17.3	17.1	-200	2.0	0.4	0.3	0.1
Particle Density, lb/cu ft	109	108			54	53	
Char, percent				78	75	75	40
Activity	0.7	0.7					
Calcine Weight Loss, percent	14.52	13.57					
Ultimate Analysis, Wt %							
C				75.60	76.13	76.13	75.90
H				0.95	0.96	1.02	1.05
S				0.16	0.18	0.20	0.18
H_2O				0.27	0.24	0.23	0.19

Table 13-12. SOLIDS REMOVED AT SHUTDOWN, RUN 13B (Sheet 1 of 2)

Run 13B

Date 10/10

	Regenerator Dump[1]		Gasifier Dump[2]			
	Top	Bottom	Top	Middle		Bottom
Ash in Char, Wt%			19.50	18.93	18.28	19.00
Ash Analysis, Wt.%						
SiO_2	5.52	5.44	24.63	23.82	22.09	23.63
CaO	55.52	55.73	41.66	41.68	42.78	40.78
MgO	34.49	34.28	11.76	12.16	12.67	12.50
Na_2O	0.09	0.05	2.02	2.04	1.83	2.00
Fe_2O_3	0.86	0.88	2.57	2.51	2.63	2.46
Al_2O_3	1.96	2.03	14.18	14.54	14.35	14.82
P_2O_5	0.04	0.02	0.04	0.04	0.04	0.04
TiO_2	0.09	0.05	0.55	0.60	0.63	0.61
K_2O	0.17	0.17	1.21	1.09	1.02	1.08
SO_3	1.22	1.26	1.78	2.09	2.08	2.13
Sulfide	0.26	0.25	0.09	0.09	0.01	0.01

(1) Analysis on -28 screen fraction

(2) Chemical analyses for char only - (Elutriated sample)

Table 13-12. SOLIDS REMOVED AT SHUTDOWN, RUN 13B (Sheet 2 of 2)

Run 13B

Date 10/10

	Regenerator Plug
Calcine Weight Loss, %	20.36
Elemental Analysis, Wt %	
SiO_2	5.79
CaO	55.70
MgO	34.71
Na_2O	0.08
Fe_2O_3	0.77
Al_2O_3	2.08
P_2O_5	0.02
TiO_2	0.06
K_2O	0.16
SO_3	1.10

Table 13-13. DEPOSITS, RUN 13B

RUN 14

OCTOBER 25 TO NOVEMBER 9, 1973

CO_2 ACCEPTOR PROCESS GASIFICATION

PILOT PLANT

RAPID CITY, SOUTH DAKOTA

1 SUMMARY

The Run 14 series consisted of Run 14A (October 25 - October 30) and Run 14B (November 7 - November 9). The objective of this series was to operate the plant in a fully integrated manner. To reduce regenerator deposits and calcined acceptor return line plugs, natural gas was substituted for char for initial calcination. This would reduce the amount and type of fines present. After calcination char feed would be established.

The program for Run 14A was successful in reducing deposits in the regenerator and acceptor return line. Flaking of a thin coat of scale in the acceptor return line did cause several temporary losses of circulation. However, stroking the solids flow control valve generally was successful in breaking these plugs.

During calcination, small balls were formed which were similar to those that formed in Run 12. Approximately eight hours after calcination, the acceptor hardened and ball formation appeared to cease. This acceptor was saved and used in Run 14B.

Plugging of the recycle gas furnace tubes limited flow to the gasifier boot. As a result, fluidization of the acceptor could not be maintained, and a small amount of char was carried over into the regenerator with the recarbonated acceptor. However, char stripping was not a problem.

Run 14A was ended when char transfer to the regenerator could not be established. Examination of the line below the char feed control valve showed that a hard buildup of acceptor approximately two inches thick had formed just below this valve. The deposit appeared to be calcined acceptor that had become wet and hardened.

Run 14B was to be essentially identical to Run 14A with two additions. First, the hardened acceptor from Run 14A was used for the initial startup. Secondly, the integrity of the fuel char system was checked by feeding approximately five minutes each hour during calcination.

The effect of using the hardened acceptor was diminished by the fact that an extremely high showering inventory was built up due either to insufficient pregasification of the gasifier char or too poor gas distribution in the gasifier transition section. As a result, a large amount of fresh acceptor was added to maintain the regenerator level. Extensive deposits formed on the regenerator wall. These were concentrated around the distributor ring and near the top above the acceptor withdrawal line. A paper thin wall scale of acceptor fines also formed in the calcined acceptor return line.

During calcination, a furnace coil used for air preheat ruptured, shutting the system down. Due to the emergency nature of the shutdown, the acceptor inventory of Run 14B was not fully recarbonated and may not be useful in future runs, since it is susceptible to air slaking.

Before resuming fully integrated plant operation, a series of tests with Velva lignite will be performed. This series will involve grinding and drying tests, preheater tests, and gasifier tests. The purposes of these tests are to study the effects of using Velva lignite as gasifier feedstock and to test the operation of the new zinc oxide system.

Plans for the next run have not been formalized pending results of lab studies in Library, Pennsylvania, and further data workup. This run, however, will probably use dead burned dolomite as the original acceptor inventory. This dolomite has been fired to 3400°F to produce a physically hard, chemically inert stone, principally MgO·CaO. This should minimize acceptor fines and sulfur on the acceptor, two important contributors to acceptor standleg plugs. In addition, the calcination step will be eliminated since the stone is already calcined.

2 TEST DATA

Run 14 data are presented graphically and/or tabularly at the end of this run report. These figures and tables include:

Page

Figure 14-1. Correlation Between TCV-2030 Loading and Acceptor Flow Rate 126

Figure 14-2. Calcination Curve, Run 14A 127

Figure 14-3. Calcination Curve, Run 14B 128

Figure 14-4. Gasifier Char Bed Density and Gas Flow Rates, Run 14B 129

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3 SIGNIFICANT EVENTS AND OBSERVATIONS

3.1 HISTORY OF RUNS 14A AND 14B

3.1.1 Purpose

Operate plant in a fully integrated manner with the acceptor circulating between reactors while maintaining steady state conditions throughout the system. To achieve this goal, methane will replace char to supply heat for the initial acceptor calcination. This will reduce the amount of fines in the regenerator inventory and should improve the reliability of the calcined acceptor circulation through the return line, CD-206.

3.1.2 Accomplishments

Run 14A

(1) Successfully measured acceptor circulation rate and correlated data as a function of solids flow control valve loading.

(2) Established acceptor circulation between reactors with continuous acceptor showering through the gasifier char bed.

(3) Calcined regenerator acceptor inventory using natural gas to supply the necessary heat.

(4) Maintained acceptor circulation after calcination was completed.

(5) Operated plant until acceptor aged and became hard.

(6) Determined that the char-acceptor interface could be maintained and controlled even without fluidizing the boot acceptor inventory.

Run 14B

(1) Established acceptor circulation between reactors with continuous acceptor showering through the char bed.

(2) Established calcining conditions in the regenerator using natural gas to supply heat.

3.1.3 Termination Causes

Run 14A

The plant was shut down when it became apparent that char feed from the gasifier to the regenerator could not be established because of a plugged line.

Run 14B

A tube in the regenerator air heater, B-203, ruptured due to embrittlement and pitting of the 321 S. S. tube material.

3.1.4 Other Problems

Run 14A

(1) During the initial startup period, a tube ruptured in the gasifier side flow heater, B-201-IB.

(2) The char grinding system baghouse was inoperable during most of the run.

(3) The gasifier boot recycle gas heater, B-201-IA, partially plugged thus reducing the gas flow available.

(4) Pipe scale which broke from the interior wall of CD-206 periodically plugged TCV-2030.

(5) The regenerator bottom temperature probe broke off in the reactor.

(6) The new flue gas quenching device continued to plug.

Run 14B

(1) During startup, some residual material (sand-Bentonite-iron-nickel sulfide mixture) from the tube cleaning operation had to be blown out of the line between the B-201-IA heater and the gasifier.

(2) The char-acceptor interface was lost when F-213 was overpressured during an attempted boot draining operation.

(3) Material continued to buildup on the shaft of the new flue gas quenching device and thereby restricted the gas flow.

(4) Acceptor showering became difficult with the result that an excessive amount of stone was retained in the gasifier char bed.

3.2 CHRONOLOGY OF RUN 14A

Date	Time	Description
10/25	1345	Started system pressuring
"	1700	Started recycle compressors
"	1725	Lit process heaters
"	2340	Started steam to side flow of gasifier
10/26	0950	Started dolomite addition to gasifier
"	1350	Started char grind in 100 area
"	1710	Started char to preheater
"	1900	Baghouse blower vibrating badly
"	1930	Baghouse dP high, stopped grind
"	2000	Restarted char grind
"	2040	Mill outlet temperature high, stopped char grind
10/27	0420	Dolomite inventory complete, started acceptor circulation tests
"	0730	Lost acceptor transfer through calcined acceptor standleg at flow control valve
"	0755	Circulation reestablished
"	1115	Started char addition to gasifier
"	1245	Added 30,000 SCFH air to regenerator to expand bed
"	1800	10,000 SCFH air to gasifier for char pregasification
"	2140	Char inventory in gasifier complete, increased air to gasifier to 15,000 SCFH
10/28	0300	Reducing B-203 and B-204 heaters to 1000°F
"	0645	Reduced air to gasifier to 14,000 SCFH
"	0715	Initiated acceptor circulation
"	0730	Preparing for char grind
"	0825	Methane addition to regenerator started, bed temperature, 1120°F
"	1000	B-203 and B-204 heaters reduced to 800°F
"	1205	100 area down for maintenance, leak at baghouse
"	1500	Regenerator temperature, 1500°F
"	1540	High dP at gasifier heaters, losing boot flow
"	1600	B-201-IA gasifier boot heater temperature reduced, started to remove methane from regenerator
"	1745	Methane back to regenerator
"	1800	Regenerator bed temperature, 1600°F
"	1830	Slight oxygen breakthrough in regenerator, bed temperature, 1650°F
"	1920	Regenerator quench tower venturi fully open
"	2015	Removed all air from side of gasifier
"	2035	One root of air back to side of gasifier
"	2300	Regenerator bed temperature, 1700°F
"	2315	Slight oxygen breakthrough in regenerator
10/29	0030	Open 2-inch bypass around HPC system
"	0100	Oxygen breakthrough in regenerator for approximately 15 minutes, 2.7 percent oxygen, bed temperature, 1770°F
"	0230	Broke plug in "Jim Dandy," all flow back through HPC system

Page	Time	Description
10/29	0250	Slight oxygen breakthrough in regenerator
"	0300	Regenerator bed completely calcined
"	0330	Regenerator bed temperature, 1800°F
"	0400	Lost thermocouple bundle in bottom of regenerator
"	0430	Regenerator bed temperature, 1700°F
"	0720	Slight oxygen breakthrough in regenerator
"	0830	Oxygen breakthrough in regenerator for approximately 10 minutes
"	0850	Regenerator bed temperature, 1800°F
"	0920	Regenerator bed temperature, 1700°F
"	1000	Regenerator bed temperature, 1670°F
"	1030	Regenerator bed temperature, 1700°F
"	1130	Regenerator bed temperature, 1750°F
"	1200	Regenerator bed temperature, 1700°F
"	1230	Lost dolomite circulation through TCV-2030, regenerator bed temperature, 1660°F
"	1310	Regenerator bed temperature, 1750°F
"	1330	Acceptor circulation reestablished
"	1430	Regenerator bed temperature, 1700°F
"	1500	Lost acceptor circulation through TCV-2030, regenerator bed temperature, 1750°F
"	1530	Regenerator bed temperature, 1700°F
"	1545	Reestablished acceptor circulation through TCV-2030, lost acceptor circulation through LCV-2003
"	1600	Acceptor circulation reestablished
"	1630	Regenerator bed temperature, 1600°F
"	1700	Started trying to transfer char to regenerator (during evening attempted char grind in 100 area. After approximately one hour, high dP on baghouse forced shutdown)
10/30	0000	Opened 2-inch bypass around HPC system to increase regenerator recycle compressor suction
"	0045	Lost acceptor circulation through TCV-2030
"	0130	Possible oxygen breakthrough in regenerator, analyzers questionable
"	0200	Started char grind in 100 area
"	0255	High dP on baghouse forced shutdown of 100 area
"	0300	Regenerator bed temperature, 1500°F
"	0530	Acceptor circulation reestablished
"	0610	Lost acceptor circulation through TCV-2030 momentarily
"	0650	Lost acceptor circulation through TCV-2030
"	0720	Reestablished acceptor circulation, needed additional flow in regenerator, added air, atmosphere oxidizing
"	0730	Regenerator bed temperature, 1600°F
"	0815	Lost acceptor circulation at LCV-2003
"	0830	Acceptor circulation reestablished
"	0900	Lost acceptor circulation through TCV-2030 momentarily

Date	Time	Description
10/30	1030	Lost seal at LCV-2003
"	1100	Acceptor circulation reestablished
"	1500-2200	Lost and regained circulation several times trying to initiate char transfer
"	1700	Regenerator bed temperature, 1550°F
"	1800	Regenerator bed temperature, 1250°F
"	2200	Since char feed to the regenerator could not be established, started plant shutdown

3.3 CHRONOLOGY OF RUN 14B

Date	Time	Description
11/6	2035	System at 150 PSIG
"	2100-2110	Gas circulation started
"	2215	Heaters lit
11/7		Some frozen lines because of ambient temperatures, thawed and opened lines
"	0730	Steam put into gasifier side flow, recycle removed
"	0750	53 PSI drop across gasifier "tee"--system coming down to repair
"	1045	Rolled "tee"--blew air through B-201-IA coils. Blew again with HP steam approximately 90,000 SCFH, cleared plug
"	1250	Repressuring system
"	1400	Pressured and heating
"	1600	Two-inch bypass closed around HPC system. Regenerator overhead gas analyzers in service
"	1715	Recycle out and steam in gasifier side flow
"	----	Thawed more sensing lines and cleared blowdown lines on suction pots, J-201 A/B
"	2330	Started acceptor to gasifier
11/8	0030	dPR-2073 began indicating. Started feeding from F-206 as well as F-204 A/B
"	0200	dPR-2074 began indicating
"	0400	dPR-2075 began indicating 100 area has loose buckets in elevator for dolomite grinding
"	0610	dPR-2076 began indicating
"	0625	Started acceptor feeding from F-206
"	0900	Added Tote Bin NO. 7 to F-204 B
"	1000	Regenerator full. Circulation started. Added air to expand regenerator bed
"	1030	Added inert gas to char line after adding 40,000 SCFH air to regenerator to expand bed
"	1120	Halted circulation tests. Pulled acceptor samples at S-9 and S-10 during circulation

Date	Time	Description
"	1125	Drained S-13A sample station on first floor at LCV-2002
"	1150	Char fed to gasifier
"	1400	Lost interface
"	1715	Dumping gasifier boot to F-213
"	1735	Circulated rock for 15 minutes
"	1815	Char fed to gasifier
"	2300	Opened block valves around gasifier air control valve, FCV-2013
"	1900-2100	Ground char to preheater
11/9	0200	dPR-2032 began indicating
"	0300	dPRC-2000 began indicating
"	0350	Sealed regenerator fuel char standleg
"	0600	Char bed established dPRC-2000 at 45 lines. Started down on heater temperatures (B-203 and B-204)
"	0745	Started acceptor makeup to regenerator
"	0830	Air started to gasifier at 5,300 SCFH
"	0850	Methane to regenerator at 1,000 SCFH
"	0855	Stopped makeup to regenerator
"	0905	Started reducing air to regenerator
"	0940	Removed recycle in air line to regenerator
"	0945	Increased steam flow to gasifier
"	0950	Reducing boot flow to allow material to shower through bed
"	1000	Adjusting air and CH_4 to desired target conditions
"	1030	Reduced gasifier steam flow from 64,000 SCFH to 59,000 SCFH
"	1100	Started char feed to regenerator. Some transferred irratically
"	1100	Started taking scheduled hourly circulating acceptor samples
"	1140	Char started to regenerator for 5 minutes
"	1200	Trouble with gasifier quench system-carryover to gasifier knock-out pot
"	1230	Char feed to regenerator for 5 minutes
"	1300	Tightened packing leak on raw acceptor feeder
"	1400	Tried raising boot level to attempt improvement in showering
"	1430	Reduced boot level back to normal
"	1620	Transfer char to regenerator for 5 minutes to check operability of feed line
"	1720	Transfer char to regenerator for 5 minutes to check operability of feed line
"	1725	Stroked TCV-2030 to help circulation
"	1800	Lost circulation overhead, low bed level
"	1810	Circulation started again
"	1812	Air out of gasifier

Date	Time	Description
11/9	1820	Transfer char to regenerator for 5 minutes to check operability of feed line
"	1830	Air back to gasifier
"	1830	Cool regenerator
"	1835	Ceased acceptor makeup to regenerator to charge F-206
"	1837	Stopped acceptor circulation because of high gasifier char bed density. Periodically fed acceptor to gasifier to keep standleg hot
"	1910	Fire aroung shaft LCV-2003, packing leaking
"	1915	Ruptured B-203 heater tube. Shutdown

4 RESULTS AND DISCUSSION

4.1 BACKGROUND

Previous experience has indicated that, at least in part, regenerator deposits and calcined acceptor return line plugs result from the presence of large amounts of fines and the chemical nature of the fines. The run program for Run 14 varied from previous ones by substituting natural gas for char to supply the heat for calcination. The purpose of this was to reduce the amount and to change the chemical properties of the fines in the regenerator and in the calcined acceptor standleg.

As in the Run 13 series, regenerator bottom temperatures were monitored to prevent a hot bottom which was shown to cause ball formation and excessive deposits in the regenerator. Maintaining the concentration of carbon monoxide and hydrogen below 5 percent was effective in reducing the bottom temperature.

Acceptor circulation and makeup also affect the bottom temperature, as shown in the Run 12 series. By virtue of its sensible and chemical heat requirements, circulated acceptor provides a significant heat sink. Thus, should the circulation stop, instructions were to cool the regenerator bed to 1600°F.

During the Run 13 series, the regenerator flue gas quenching system failed to perform effectively. Deposits built up on the shaft causing excessive pressure drop which reduced the capacity of the recycle compressors. There were two possible causes for this buildup. The water flow rate was not directly measured and was probably smaller than desired. Secondly, operation of the shaker was lost during long periods of the runs permitting an accumulation which could not be dislodged when the shaker was restarted. For Run 14B, the amount of water was measured and controlled.

4.2 ACCOMPLISHMENTS

In Run 14A and possibly in Run 14B, the regenerator inventory was calcined. Figures 14-2 and 14-3 are the calcination curves for these runs.

Twenty hours of circulating calcined acceptor to the gasifier were logged in Run 14A. The run program was successful in reducing deposits in the regenerator and the acceptor return line. In addition, the acceptor became hardened and the fines often associated with the calcined material disappeared (see Table 14-6).

Plugging of the gasifier recycle gas furnace tubes again limited flow to the boot. This did not, however, result in any serious problems. The char-acceptor interface was maintained, and no difficulties in

transferring recarbonated acceptor were encountered. However, a small amount of char remained entrained with the acceptor and was carried with it into the regenerator. Until the range of operability for the gasifier boot flow can be established (particularly when steam is used to fluidize the acceptor), the preferred mode of operation is to maintain the boot acceptor at incipient fluidization.

The program of Run 14 specified methane calcination to reduce the amount and type of fines present in the regenerator. The purpose was to reduce ball formation as well as regenerator deposits. In Run 14A this procedure worked very well. The stone, although soft immediately after calcining, became hardened with time. The balls formed initially were small, generally less than one-quarter of an inch in diameter. As the acceptor hardened, ball formation appeared to cease and some of them were broken up. This fracturing may have been due to the calcining of the central acceptor fragment. The trapped carbon dioxide then broke open these balls. The fracturing may also have been due to attrition as the large particles were transferred from the engager pot to the regenerator.

In Run 14B the new flue gas quencher operated better than in previous runs. The water flow rate was measured directly for the first time. The amount of buildup was small with a significant accumulation only at the point of water injection. However, the fines loading to the device was probably less than in previous runs since (1) 14B was of relatively short duration, (2) char fines were not present, and (3) much of the acceptor inventory was hardened in Run 14A and probably did not attrite as rapidly as the new stone.

In the plant there is no means of directly measuring the acceptor circulation rate. An estimate of this variable would be desirable as a check for the circulation rate calculated from heat and material balances. Therefore, a procedure was devised to obtain an empirical correlation between TCV-2030 valve loading and the circulation rate. The procedure was simply to:

(1) Fill the regenerator with dolomite acceptor.

(2) Half-calcine the stone so that a material of constant particle density would be circulated.

(3) Without feeding acceptor to the gasifier, drain out and reduce the boot inventory to a low level (25 lines or 11.625 IN. WC on dPR-2034).

(4) Finally, measure the time necessary to fill the gasifier boot at a given valve loading on TCV-2030 without withdrawing material from the gasifier.

The raw data for the tests, which were conducted during Run 14A, are shown in Table 14-1. Figure 14-1 illustrates the correlation between the circulation rate and the valve loading. As shown, the data appear to be precise since there is little scatter.

Since many other variables besides valve loading or setting can affect the circulation rate, the correlation should be used only as an estimate of the true value. The amount of line purge, the differential pressure between reactors, acceptor particle density, and acceptor size can all affect the actual circulation rate.

4.3 PROBLEMS

In Run 14A, char combustion was delayed because of a low char inventory. The program had called for combustion within four hours of calcination. However, initial char feed attempts were unsuccessful. Problems with the char baghouse resulting in a low char inventory delayed further attempts. When these problems were corrected, regenerator char feed could not be established. After shutdown, examination of the char feed line below the control valve showed that a hard buildup of acceptor approximately two inches thick had formed just below the valve. This deposit appeared to be calcined acceptor that had become wet and hardened. Table 14-18 gives an elemental analysis of the deposit.

During Run 14A, char grinding became unreliable and slowed down operations. While grinding to refill the preheater, a gasket on the baghouse began leaking. This filled the 100 area with char fines. Examination of the wool bags, after the baghouse was opened, showed that the bottoms had been burned. These bags were replaced with new wool bags. Some broken hoses were replaced, and the gasket was repaired. When restarted the baghouse developed a high pressure drop. This could only be cleared by blowing the bags for more than an hour with no char in the system. At Buffalo Forge's recommendation, the bags were re-oriented so that the seams were aligned with the blow rings. However, this did not improve their operation. At this point, Run 14A ended.

During the shutdown, the blow rings were cleared and the bottom cone of the baghouse was reinsulated. Currently, these repairs appear to have solved the problem.

The reinforced section of the thermocouple bundle in the regenerator bottom broke off during Run 14A leaving only two of the original seven thermocouples functional during Run 14B. Since the probe has proven of value, a similar one will be installed for the next run.

Run 14B was cut short when a furnace tube in the air heater ruptured. The rupture appeared to be the result of embrittlement. When a quick repair proved impossible, the plant was shut down for installation of new equipment and repair of present equipment.

During both runs, some regenerator wall scale deposits were formed. Since the deposits were not large enough to cause operating problems and since the shutdown was to be of short duration, the regenerator was not cleaned following Run 14A. Following Run 14B, the regenerator was inspected and cleaned. The total wall scale accumulation for both runs was approximately one-half inch thick and was concentrated around the distributor ring at the bottom and near the top above the acceptor withdrawal line. The deposits had the same appearance as those described in previous run reports.

Thin wall scale consisting of cemented acceptor fines formed in the calcined acceptor return standleg in both Run 14A and Run 14B. This scale presented only minor problems. Flaking of this scale resulted in temporary loss of circulation several times in Run 14A. Stroking of the control valve was generally successful in breaking up these plugs and reestablishing flow. After twenty hours of circulation, the scale appeared to be wearing away due to the scrubbing action of the acceptor flow. Acceptor showering during Run 14B resulted in a considerable stone inventory in the gasifier char bed. Because of this retention, a large amount of fresh stone was fed as makeup to maintain the regenerator bed level. Therefore, much of the advantage gained by using hardened acceptor was lost.

Since retention of large amounts of acceptor in the char bed leads to a degenerate condition in which the bed density continues to increase, attempts were made to improve the acceptor showering. As shown in Figures 14-4 and 14-5, adjustment of the gas distribution and flow rates had little effect upon showering. Lack of sufficient char pregasification to reduce the initial char bed density may have been responsible for the acceptor retention. However, poor gas distribution in the transition section appears to be a more likely cause. Inspection of the side flow gas distribution following the 14B shutdown showed that about one-third of the distributor bubble caps were plugged.

5 FUTURE PLANS

Plans are to extend the Run 14B shutdown to eliminate most problems which have hampered operations in past runs. Particular emphasis will be given to solving the heater corrosion problems. The coils in the gasifier boot heater, B-201-IA, and the gasifier side flow heater, B-201-IB, will be replaced. In addition, the cold end of the regenerator air heater, B-203, which failed will be replaced with an Incoloy coil from the devolatilizer boot heater, B-201-IIA.

To protect the new gasifier boot heater from sulfur attack, a zinc oxide sulfur removal system will be installed.

The other process modifications include the installation of a scalping screen in the char grinding system. This should improve the control of the size consist of the gasifier feedstock by reducing the amount of fines fed to the system. Previously, the fines (-100 mesh material) served only as a heat load on the system since they were carried out of the gasifier in the product gases. Also, modification of the engager pot is planned to eliminate a major source of acceptor attrition. The engager pot is the pick up point for pneumatic transfer of recarbonated acceptor to the regenerator.

While the shutdown items are being completed, tests involving the use of Velva lignite will be made. These tests will include grinding, drying, and preheater studies. Preoxidation of the lignite will be attempted.

Following the completion of the gasifier shutdown items, the gasifier will be operated with Husky char and Velva lignite. This will allow testing of the zinc oxide system and provide information on the effects of using Velva lignite as a feedstock. Although not anticipated several potential problems could be encountered with the use of the lignite. These are:

(1) Quench tower and back pressure control problems caused by tar-like materials in the gasifier product gas.

(2) Particle swelling of non-pretreated lignite.

(3) The occurrence of gasifier deposits.

These potential problems will be examined in the run. Also data on the kinetic effects of the lignite volatile material on the steam fixed carbon reaction should be obtained.

Plans for the next run with circulating acceptor have not been formalized pending further data workup at Rapid City and lab studies in Library. However, the run will probably use dead burned dolomite

as a substitute material for the acceptor. This material is chemically inert and should simplify the startup procedure since the difficult calcination step will be reduced to a simple heatup. Additionally, the use of dead burned dolomite will allow a range of acceptor ages to exist in the system as the dead burned material is replaced with raw dolomite. When the replacement is complete, the acceptor inventory should be physically hard and the regenerator fines inventory should be low.

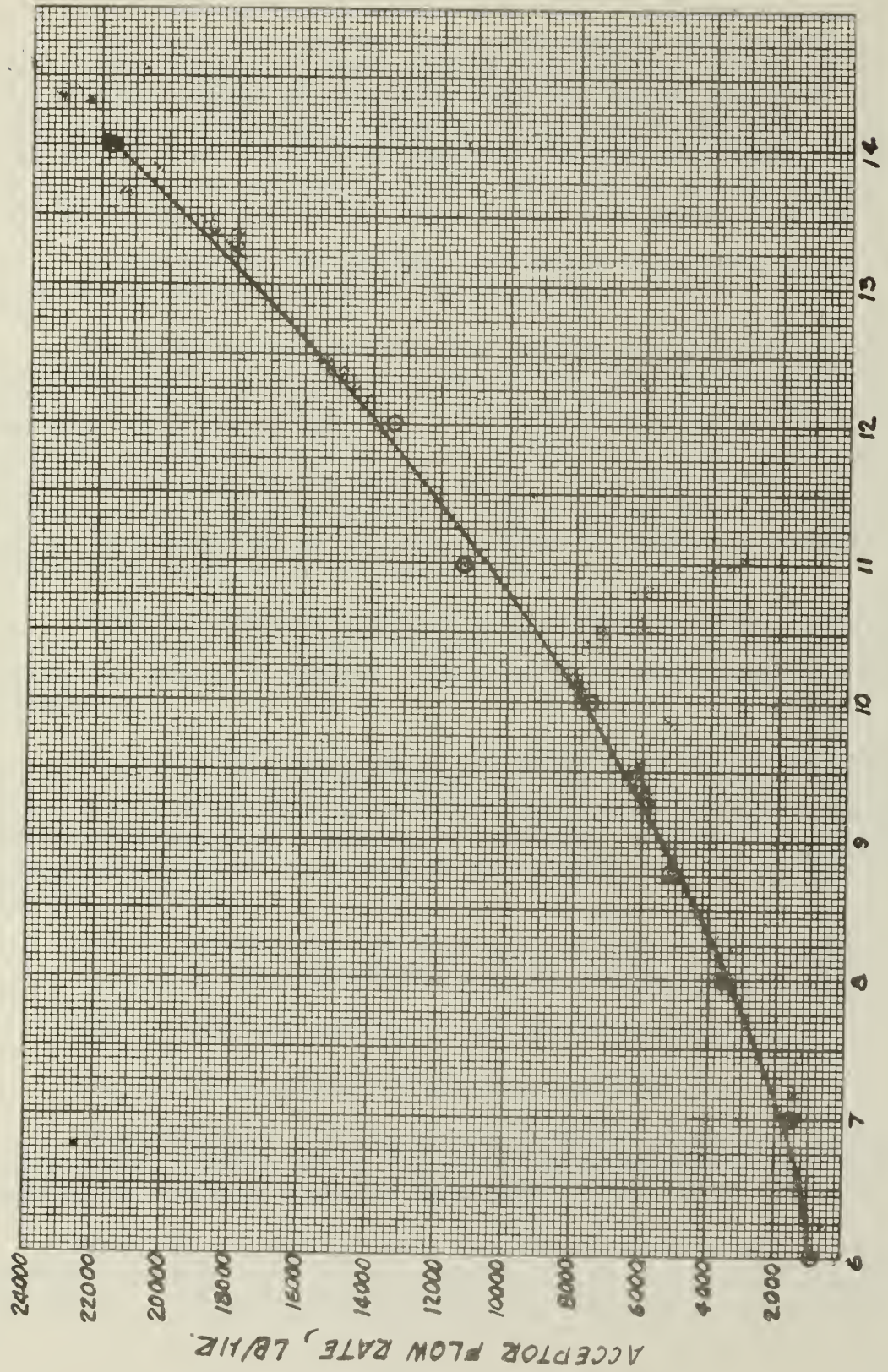

Figure 14-1. CORRELATION BETWEEN TCV-2030 LOADING AND ACCEPTOR FLOW RATE

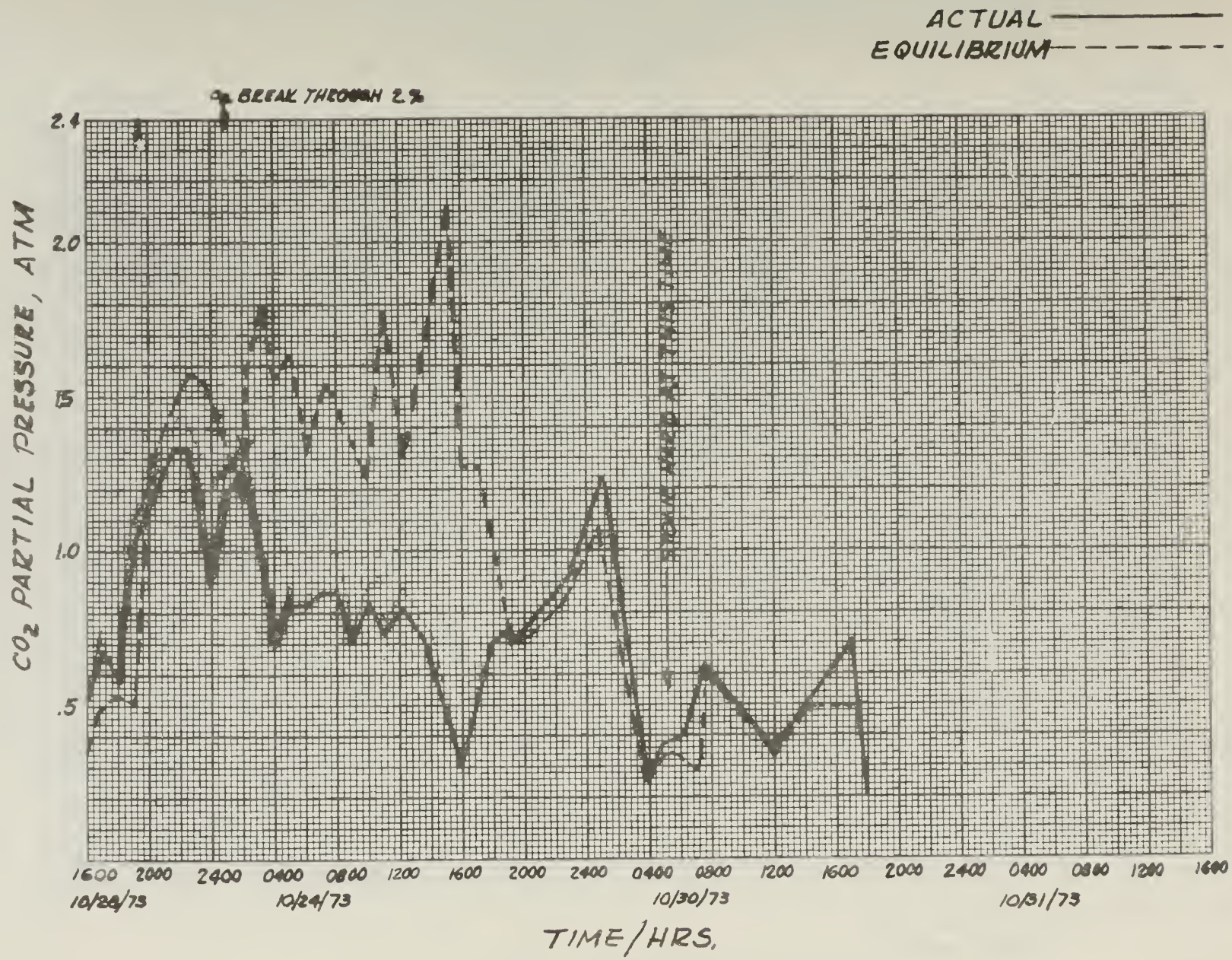

Figure 14-2. CALCINATION CURVE, RUN 14A

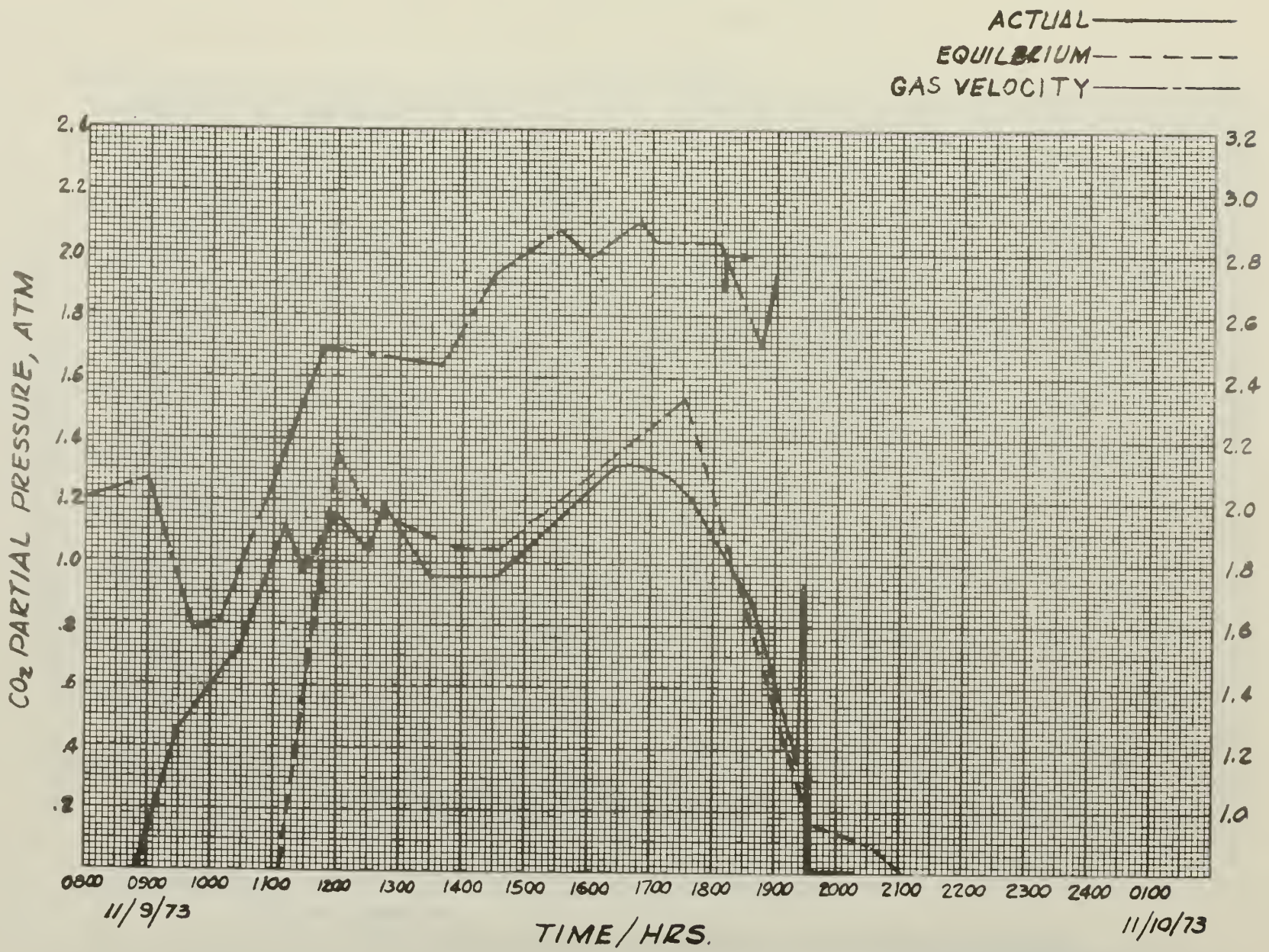

Figure 14-3. CALCINATION CURVE, RUN 14B

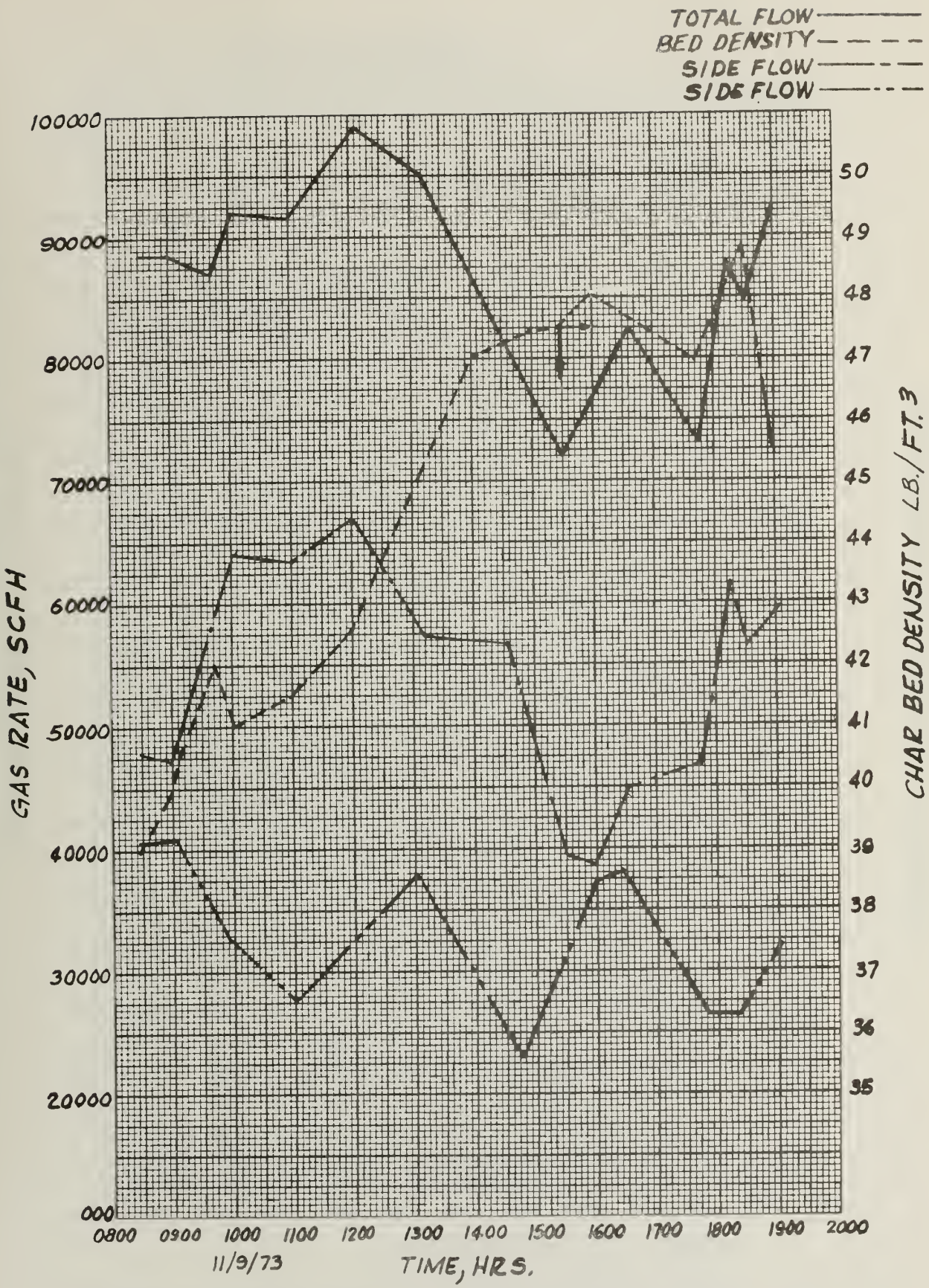

Figure 14-4. GASIFIER CHAR BED DENSITY AND GAS FLOW RATES, RUN 14B

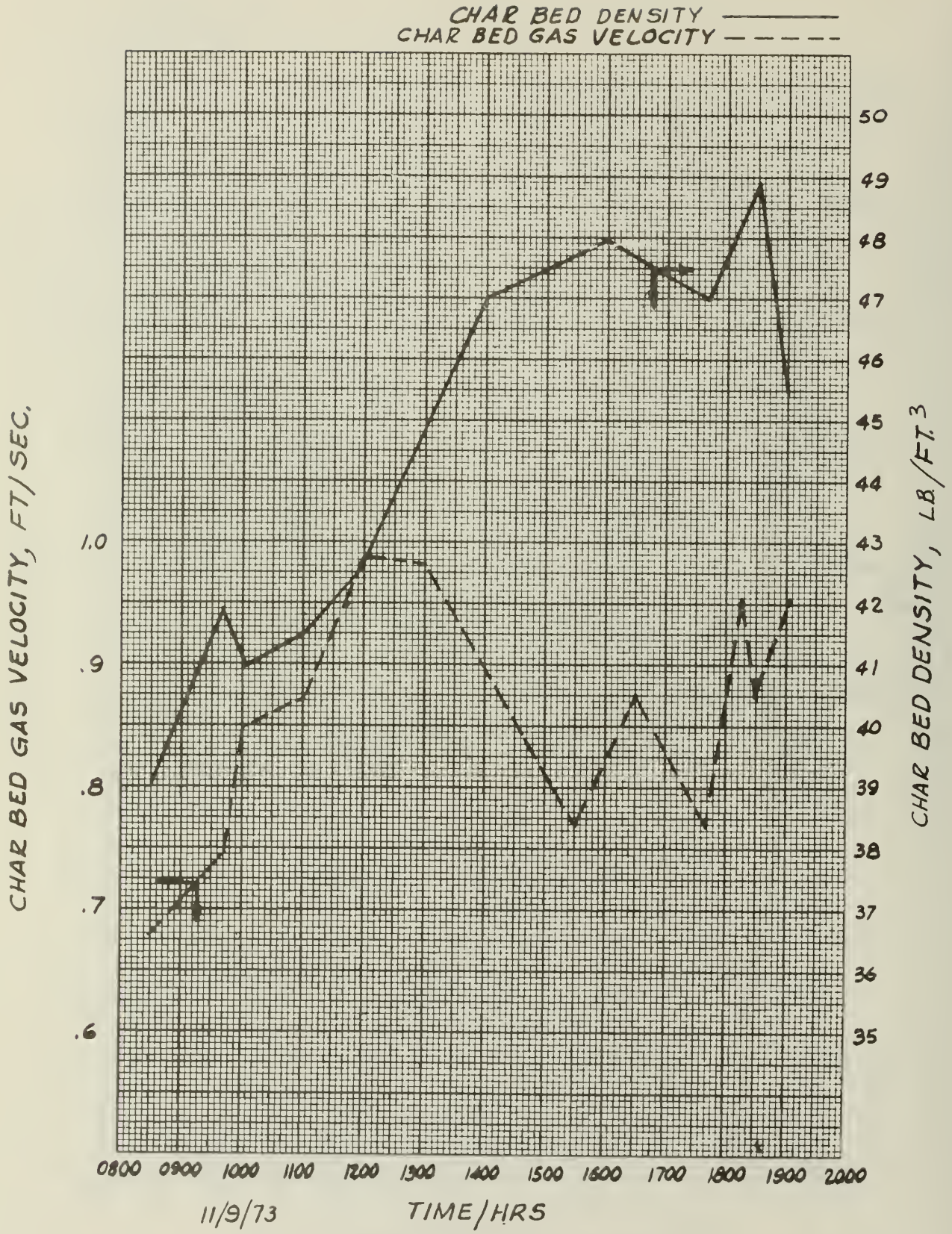

Figure 14-5. GASIFIER CHAR BED DENSITY--CHAR BED GAS VELOCITY, RUN 14B

Date 10/27/73

Test	Gasifier Boot Temperature, °F	Boot Gas Rate, SCFH	TCV-2030 Loading, PSI	Fill Time (1)	Boot dP Changes, IN H_2O dPR-2034	dPR-2035	dPR-2002	dPR-2001	dP Across TCV-2030 dPR-2035, IN H_2O	dP Between TCV-2030 And Regenerator dPR-2025, IN H_2O	Stone Weight, Lbs	Flow Rate, Lb/Hr
1	1100	35,000	6	23'-30"	18.14	20.83	35.10	0.26	- 6.0	189	346	880
2	1100	35,000	7	13'-5"	18.14	21.15	33.64	0.26	- 6.0	189	349	1,600
3	1140	32,000	8.75	4'-5"	18.14	23.08	35.10	0.51	- 9.4	97.5	351	5,150
4	1140	31,000	10	2'-57"	18.14	25.64	36.86	3.57	- 9.3	99.0	370	7,530
5	1140	31,000	11	2'-10"	18.60	29.49	37.44	8.16	-10.0	102.0	407	11,300
6	1140	31,000	12	1'-38"	18.60	24.36	36.27	2.04	-13.0	114.0	365	13,400
7	1140	31,000	14	1'-0"	19.29	24.36	37.15	2.04	-14.0	114.0	362	21,700
8	1140	31,000	8	6'-0"	19.07	24.36	35.39	1.53	-11.2	102.0	358	3,580

Acceptor Particle Density, Lb/Cu Ft - 127

Bulk Density Used, Lb/Cu Ft - 65

(1), --Minutes, "--Seconds

Table 14-1. ACCEPTOR CIRCULATION TEST DATA

Date	10/28	10/28	10/28	10/29	10/29	10/29	10/29	10/29	10/29	10/30	10/30	10/30	10/30
Time	1300	1700	2140	0100	0500	0900	1300	1700	2100	0200	0600	0700	1300
Regenerator													
Dolomite Lift, SCFH	76,600	105,000	92,600	92,000	92,700	99,800	98,600	108,000	105,000	99,100	110,000	101,000	98,500
Char Lift, SCFH(1)	6,870	6,970	6,570	6,600	6,600	10,100	10,700	6,770	6,910	6,980	9,900	8,710	11,800
Recycle - Air Line, SCFH	26,400	0	0	0	0	0	0	0	0	0	0	0	13,700
Air, SCFH	30,600	21,800	57,500	48,900	54,400	32,700	40,300	32,800	39,300	15,300	25,200	21,800	67,500
Total	140,470	133,770	156,670	147,500	153,700	142,600	149,100	147,570	151,210	121,380	145,100	131,510	191,500
Vent Rate, SCFH	33,900	18,600	57,400	46,900	40,100	39,000	46,100	34,000	21,700	21,600	26,000	28,600	71,400
Average Bed Temperature, °F	1365	1575	1710	1670	1760	1750	1750	1595	1620	1540	1530	1565	1560
Bed Velocity, Ft/Sec	2.08	2.21	2.75	2.54	2.76	2.55	2.67	2.45	2.55	1.97	2.34	2.16	3.13
Bed Density, Lb/Ft^3	67-80	70-90	62-80	55-74	50-77	55-82	72-83	75-89	63-95	82-95	67-95	90-99	93-99
Gasifier													
Boot, SCFH	29,400	22,000	26,600	29,000	28,800	28,600	25,400	24,300	24,900	24,400	25,000	25,000	24,800
Steam, SCFH	32,300	34,000	41,600	42,400	42,100	42,200	42,700	42,600	42,500	45,300	45,300	45,300	45,400
Air, SCFH	14,100	14,100	1,870	0	1,890	1,880	1,890	8,620	3,760	5,600	4,110	5,600	5,600
Total	75,800	70,100	70,070	71,400	72,790	72,680	69,990	75,520	71,160	75,300	74,410	75,900	75,800
Vent Rate, SCFH	22,600	29,100	10,100	10,300	0	10,100	9,420	19,200	19,700	15,700	12,300	12,100	17,800
Boot Temperature, °F	1280	1150	840	815	820	827	820	800	905	785	855	835	870
Bed Temperature, °F	1445	1430	1405	1395	1375	1395	1335	1380	1445	1275	1355	1350	1315
Boot Velocity, Ft/Sec	1.38	0.956	0.933	0.998	0.995	0.992	0.879	0.827	0.917	0.819	0.887	0.873	0.887
Bed Velocity, Ft/Sec	0.789	0.724	0.714	0.723	0.730	0.736	0.687	0.780	0.741	0.714	0.738	0.750	0.735
Boot Density, Lb/Ft^3	63	36	35	33	37	38	38	38	46	40	41	51	55
Bed Density, Lb/Ft^3	39	42	43	32	30	29	27.5	26	33	30	34	31.5	32.5
Gross Btu, BTU/SCF	123	148	212	207	191	193	140	137	188	136	129	135	122

(1) Not corrected for methane
(2) N_2 included

Table 14-2. REGENERATOR - GASIFIER DATA, 10/28/73-10/30/73, RUN 14A

Run 14A

Date 10/25-10/30

	Dolomite			Char[1]
Screen Size Tyler Mesh	6 X 16[2] Wt %	6 X 9[2] Wt %	Screen Size	Wt %
+4	0	0	+6	0
4 X 6	0	0.2	6 X 8	0.4
6 X 8	10.5	25.0	8 X 10	1.4
8 X 9	20.1	28.1	10 X 14	4.2
9 X 10	17.7	23.4	14 X 20	7.2
10 X 12	13.8	14.3	20 X 28	9.7
12 X 14	14.5	6.8	28 X 35	10.0
14 X 16	11.7	1.4	35 X 48	10.4
16 X 20	9.2	0.4	48 X 65	8.2
20 X 24	1.9	0.2	65 X 100	6.6
24 X 28	0.3	Tr	100 X 200	11.0
-28	0.2	0.2	-200	30.9
Particle Density, Lb/Cu Ft	168			79.4
Ultimate Analysis, Wt %[3]				
C				67.37
H				2.21
S				1.58
H_2O				0.80
Ash				19.73
Elemental Analysis, Wt %[4]				
SiO_2		5.35		40.14
CaO		52.55		19.56
MgO		38.99		5.66
Na_2O		0.09		0.88
Fe_2O_3		0.90		6.03
Al_2O_3		1.73		8.74
P_2O_5		0		0.02
TiO_2		0		0.54
K_2O		0.39		0.26
SO_3		0.72		18.58
Sulfide[3]		0		<0.01

(1) Two samples
(2) Typical screenings
(3) As received basis
(4) Of calcined basis or total ash basis

Table 14-3. FEEDSTOCK COMPOSITES, RUN 14A

Run 14B

Date 11/7-11/9

	Dolomite[1]			Char[2]
Screen Size Tyler Mesh	6 X 16[3] Wt %	6 X 9[4] Wt %	Screen Size Tyler Mesh	Wt %
+4	0	0.2	+6	0
4 X 6	0	3.1	6 X 8	1.0
6 X 8	16.4	37.6	8 X 10	3.4
8 X 9	18.9	28.6	10 X 14	10.1
9 X 10	17.0	21.9	14 X 20	15.3
10 X 12	13.0	7.0	20 X 28	18.3
12 X 14	12.8	1.2	28 X 35	15.1
14 X 16	9.4	0.1	35 X 48	12.8
16 X 20	8.3	0.1	48 X 65	8.3
20 X 24	3.1	0	65 X 100	5.1
24 X 28	0.7	0	100 X 200	5.6
-28	0.4	0.3	-200	5.0

Ultimate Analysis, Wt %[5]	
C	66.87
H	2.19
S	1.72
H_2O	1.57
Ash	20.88

Elemental Analysis, Wt %[6]	
SiO_2	30.42
CaO	22.66
MgO	6.43
Na_2O	1.81
Fe_2O_3	7.28
Al_2O_3	10.28
P_2O_5	0.25
TiO_2	0.40
K_2O	0.34
SO_3	20.22
Sulfide[5]	0.02

(1) Regenerator dump from 14A not included in screens
(2) Composite of eight screenings
(3) One sample
(4) Six samples
(5) As received basis
(6) Calcined basis or total ash basis

Table 14-4. FEEDSTOCK COMPOSITES, RUN 14B

Run 14A

	Calcined Acceptor Return								
Date	10/27[1]	10/28	10/28	10/28	10/28	10/28	10/28	10/29	10/29
Time	0510	0800	1010	1200	1510	2000	2400	0400	0800
Screen Size Tyler Mesh	← Weight Percent →								
+4	0.2	0	0.6	0.1	0.1	0	0	3.2	7.5
4 X 6	1.0	0.3	1.8	1.1	0.5	0.7	4.9	11.4	16.6
6 X 8	14.0	15.8	19.7	23.3	19.0	15.9	18.1	20.8	16.6
8 X 9	13.1	20.0	20.0	23.8	22.8	19.0	10.2	10.6	8.9
9 X 10	11.9	17.5	17.2	19.7	20.9	17.1	11.9	12.4	11.2
10 X 12	8.5	14.0	12.0	12.9	13.8	12.7	9.3	9.3	8.5
12 X 14	9.1	12.9	10.3	9.3	11.2	11.6	8.6	8.8	8.1
14 X 16	7.5	8.4	6.7	4.7	5.9	8.5	6.1	6.0	5.6
16 X 20	6.7	5.9	5.6	2.7	3.4	7.1	5.9	4.7	4.7
20 X 24	2.8	2.4	2.5	1.0	1.2	3.0	1.4	2.6	2.8
24 X 28	1.9	1.5	1.6	0.6	0.5	1.8	9.1	2.2	2.3
-28	23.2	1.3	2.0	0.7	0.7	2.3	14.5	8.0	7.1
Particle Density, Lb/Cu Ft		128						108	112
Activity	1	0.9				0.6		0.2	0.2
Carbonation Ratio	1	0.9				0.5		0	0

Table 14-5. CIRCULATED ACCEPTOR, CALCINED ACCEPTOR RETURN, RUN 14A (Sheet 1 of 2)

Run 14A

	Calcined Acceptor Return								
Date	10/27[1]	10/28	10/28	10/28	10/28	10/28	10/28	10/29	10/29
Time	0510	0800	1010	1200	1510	2000	2400	0400	0800
Elemental Analysis, Wt %[2]									
SiO_2		5.34							6.31
CaO		53.02							51.91
MgO		38.61							38.13
Na_2O		0.12							0.09
Fe_2O_3		0.63							0.75
Al_2O_3		1.75							2.08
P_2O_5		0							0.03
TiO_2		0							0
K_2O		0.30							0.16
SO_3		0.52		0.50			0.55	0.60	0.18
Sulfide		0.014		0.013			0.20	0.084	0.05

(1) Before establishing char bed
(2) Calcined basis

Table 14-5. CIRCULATED ACCEPTOR, CALCINED ACCEPTOR RETURN, RUN 14A (Sheet 2 of 2)

Run 14A

	Calcined Acceptor Return						
Date	10/29	10/29	10/29	10/30	10/30	10/30	10/30
Time	1300	1600	2000	0700	1200	1700	2200
Screen Size, Tyler Mesh	← Weight Percent →						
+4	6.5	7.4	1.2	0.9	1.0	0.6	0.1
4 X 6	8.3	12.5	3.7	2.6	4.2	4.8	0.7
6 X 8	18.3	13.3	9.6	8.2	12.2	13.5	3.5
8 X 9	9.7	7.5	8.2	9.2	9.6	11.1	4.4
9 X 10	11.1	9.5	11.3	12.2	12.3	14.6	6.8
10 X 12	-	7.6	10.1	11.0	9.5	10.7	7.2
12 X 14	17.8[1]	8.5	11.4	12.4	10.3	11.5	9.7
14 X 16	6.4	6.4	9.0	10.8	8.4	8.4	9.4
16 X 20	5.6	6.4	9.5	10.2	8.3	8.1	10.7
20 X 24	3.3	3.7	6.0	6.5	5.5	5.0	7.9
24 X 28	3.5	3.9	6.1	4.8	6.1	4.9	9.9
-28	9.4	13.3	13.9	10.5	12.6	6.8	29.9
Particle Density, Lb/Cu Ft				141		150	
Activity		0.2	0.44	0.45	0.45	0.6	0.62
Carbonation Ratio		0	0.3	0.45	0.45	0.6	0.62
Elemental Analysis, Wt %[2]							
SiO_2				6.4		6.12	
CaO				52.43		54.31	
MgO				36.82		35.89	
Na_2O				0.06		0.06	
Fe_2O_3				0.81		0.93	
Al_2O_3				3.03		1.87	
P_2O_5				0		0	
TiO_2				0		0	
K_2O				0.12		0.08	
SO_3	0.04			0.34		0.40	
Sulfide	0.03			0.14		0.025	

(1) Includes 10 X 12 screen
(2) Calcined basis

Table 14-6. CIRCULATED ACCEPTOR, CALCINED ACCEPTOR RETURN, (CONTINUED), RUN 14A

Run 14A

	Recarbonated Acceptor Return								
Date	10/27[1]	10/28	10/28	10/28	10/28	10/28	10/28	10/29	10/29
Time	0515	0755	1000	1200	1500	2000	2400	0400	0800
Screen Size Tyler Mesh	← Weight Percent →								
+4	0	0	0.5	0	0	0	0	3.0	7.1
4 X 6	0.4	0.7	1.7	1.1	0.8	1.0	4.1	12.3	10.8
6 X 8	15.4	18.7	21.7	20.3	16.3	11.6	20.9	21.6	12.2
8 X 9	15.8	20.5	22.0	19.6	18.5	13.5	12.6	10.6	7.2
9 X 10	13.9	17.9	19.6	19.0	18.6	15.7	13.2	11.1	10.1
10 X 12	10.3	13.2	13.0	13.5	13.1	12.6	9.7	8.1	8.2
12 X 14	10.2	11.5	9.9	11.4	11.9	12.5	9.1	8.1	9.5
14 X 16	8.2	7.0	6.1	7.1	7.6	9.4	6.9	5.8	7.5
16 X 20	7.4	4.8	3.7	4.8	6.4	9.2	7.0	5.8	7.0
20 X 24	3.8	1.7	1.2	1.8	2.7	5.3	4.3	3.8	4.8
24 X 28	2.5	1.0	0.4	0.8	3.2	4.4	4.0	3.6	4.8
-28	12.0	3.0	0.2	0.4	0.9	4.8	8.1	6.2	10.8
Particle Density, Lb/Cu Ft	137	126		123		120		131	132
Activity	1	0.85		0.9		0.8		0.6	0.48
Carbonation Ratio	1	0.85		0.9		0.8		0.6	0.48

Table 14-7. CIRCULATED ACCEPTOR, RECARBONATED ACCEPTOR RETURN, RUN 14A (Sheet 1 of 2)

Run 14A

	Recarbonated Acceptor Return								
Date	10/27[1]	10/28	10/28	10/28	10/28	10/28	10/28	10/29	10/29
Time	0515	0755	1000	1200	1500	2000	2400	0400	0800
Elemental Analysis, Wt %[2]									
SiO_2		6.18							6.99
CaO		52.88							51.88
MgO		36.24							36.47
Na_2O		0.09							0.12
Fe_2O_3		1.32							0.90
Al_2O_3		2.08							2.10
P_2O_5		0							0
TiO_2		0							0
K_2O		0.18							0.20
SO_3		1.19		0.43			1.19		0.44
Sulfide		0.42		0.083			0.32		0.14

(1) Before establishment of char bed
(2) Calcined basis

Table 14-7. CIRCULATED ACCEPTOR, RECARBONATED ACCEPTOR RETURN, RUN 14A (Sheet 2 of 2)

Run 14A

	Recarbonated Acceptor Return								
Date	10/29	10/29	10/29	10/29	10/30	10/30	10/30	10/30	10/30
Time	1200	1325	1600	2000	0600	0830	1200	1600	2039
Screen Size Tyler Mesh	← Weight Percent →								
+4	6.6	5.4	2.5	2.4	0.2	1.3	0.9	0.3	0.1
4 X 6	8.5	8.6	6.4	6.6	1.4	8.9	5.3	3.1	2.5
6 X 8	11.5	12.2	10.1	12.0	6.5	22.4	14.5	10.7	7.1
8 X 9	8.5	8.2	6.5	10.2	9.8	16.5	12.8	10.0	7.0
9 X 10	10.2	9.4	8.7	12.6	13.6	16.8	14.5	13.3	11.5
10 X 12	9.0	8.4	7.6	10.0	13.6	11.3	10.1	10.5	9.6
12 X 14	10.2	9.6	8.7	10.6	15.4	9.4	9.1	11.4	10.8
14 X 16	7.9	7.5	7.4	8.1	12.2	5.2	6.4	8.3	8.5
16 X 20	7.2	7.6	7.5	7.5	11.2	3.7	5.7	8.7	8.4
20 X 24	5.0	4.6	5.5	5.0	6.7	1.7	3.7	5.4	5.4
24 X 28	5.1	4.7	6.8	5.0	5.3	1.1	3.9	6.0	6.9
-28	10.2	13.8	22.3	10.1	3.9	1.8	13.1	12.3	22.3
Particle Density, Lb/Cu Ft				135	140	150		148	149
Activity	0.42		0.4	0.5	0.7	0.57	0.6	0.5	0.65
Carbonation Ratio	0.42		0.4	0.5	0.7	0.57	0.6	0.5	0.65

Table 14-8. CIRCULATED ACCEPTOR, RECARBONATED ACCEPTOR RETURN (CONTINUED), RUN 14A (Sheet 1 of 2)

Run 14A

	Recarbonated Acceptor Return								
Date	10/29	10/29	10/29	10/29	10/30	10/30	10/30	10/30	10/30
Time	1200	1325	1600	2000	0600	0830	1200	1600	2039
Elemental Analysis, Wt %[1]									
SiO_2						5.49		6.50	
CaO						53.33		52.83	
MgO						38.51		37.58	
Na_2O						0.07		0.09	
Fe_2O_3						0.80		1.02	
Al_2O_3						1.68		1.93	
P_2O_5						0		0	
TiO_2						0		0	
K_2O						0.07		0.14	
SO_3		0.33				0.40		0.56	
Sulfide		0.11				0.13		0.064	

[1] Calcined basis

Table 14-8. CIRCULATED ACCEPTOR, RECARBONATED ACCEPTOR RETURN (CONTINUED), RUN 14A (Sheet 2 of 2)

Run 14B

	Calcined Acceptor Return				
Date	11/8	11/9	11/9	11/9	11/9
Time	1034	0830	1100	1600	1700
Screen Size Tyler Mesh	← Weight Percent →				
+4	0.8	1.0	0.5	0.7	1.8
4 X 6	3.1	4.1	3.4	3.8	8.3
6 X 8	13.0	13.7	13.8	16.7	19.4
8 X 9	11.5	10.6	12.8	17.4	15.4
9 X 10	12.8	11.9	13.3	17.6	16.5
10 X 12	11.0	9.8	11.2	12.3	11.4
12 X 14	11.2	11.1	12.0	10.9	9.6
14 X 16	8.6	8.8	8.8	7.3	6.3
16 X 20	8.7	8.8	8.9	5.8	4.8
20 X 24	5.4	5.7	5.1	2.8	2.2
24 X 28	5.3	5.6	4.4	2.3	1.5
-28	8.6	8.8	5.7	2.4	2.9
Particle Density, Lb/Cu Ft				142	127
Activity	0.8	0.64	0.73	0.53	0.45
Carbonation Ratio	0.8	0.64	0.73	0.48	0.35
Elemental Analysis, Wt %(1)					
SiO_2				5.63	5.50
CaO				55.23	
MgO				35.79	
Na_2O				0.05	
Fe_2O_3				0.88	
Al_2O_3				1.96	
P_2O_5				0.03	
TiO_2				0.06	
K_2O				0.05	
SO_3				0.33	0.34
Sulfide				0.088	0.09

(1) Calcined basis

Table 14-9. CIRCULATED ACCEPTOR, CALCINED ACCEPTOR RETURN, RUN 14B

Run 14B

	Recarbonated Acceptor Return				
Date	11/8	11/9	11/9	11/9	11/9
Time	1034	0845	1130	1600	1800
Screen Size Tyler Mesh	← Weight Percent →				
+4	0.2	0.7	0.2	0.8	1.2
4 X 6	2.7	3.9	3.5	6.7	5.0
6 X 8	10.8	14.5	14.4	19.4	14.1
8 X 9	10.3	13.0	13.2	19.0	14.8
9 X 10	11.4	15.8	13.4	18.1	17.0
10 X 12	10.6	12.5	11.0	12.0	12.6
12 X 14	11.7	12.7	11.1	11.0	12.4
14 X 16	8.9	8.8	8.4	6.5	8.8
16 X 20	9.2	7.7	8.2	4.8	7.7
20 X 24	6.0	4.3	5.1	1.4	3.8
24 X 28	5.9	3.5	5.1	0.4	1.9
-28	12.3	2.6	6.4	0.1	0.6
Particle Density, Lb/Cu Ft			133	138	140
Activity	0.6	0.60		0.70	0.64
Carbonation Ratio	0.6	0.60		0.70	0.64
Elemental Analysis, Wt %(1)					
SiO_2				5.38	5.55
CaO				55.33	
MgO				35.86	
Na_2O				0.08	
Fe_2O_3				0.90	
Al_2O_3				1.92	
P_2O_5				0.03	
TiO_2				0.06	
K_2O				0.09	
SO_3				0.33	0.53
Sulfide				0.094	0.16

(1) Calcined basis

Table 14-10. CIRCULATED ACCEPTOR, RECARBONATED ACCEPTOR RETURN, RUN 14B

Run 14A

Date 10/29

Time 1640

Screen Size Tyler Mesh	Withdrawn From System Wt %
+4	1.2
4 X 6	4.0
6 X 8	8.1
8 X 9	6.7
9 X 10	9.3
10 X 12	8.6
12 X 14	9.8
14 X 16	7.9
16 X 20	7.5
20 X 24	5.2
24 X 28	5.9
-28	25.8
Particle Density, Lb/Cu Ft	137

Table 14-11. CIRCULATED ACCEPTOR, RUN 14A

Run 14A

Date 10/29

Screen Size Tyler Mesh	Wt %
+6	0
6 X 8	1.1
8 X 10	3.0
10 X 14	10.1
14 X 20	13.5
20 X 28	17.3
28 X 35	16.6
35 X 48	16.9
48 X 65	11.5
65 X 100	5.6
100 X 200	3.0
-200	0.8

Ultimate Analysis, Wt %(1)	
C	68.40
H	0.91
S	0.10
H_2O	0.11
Ash	26.72

Elemental Analysis Wt %(2)	
SiO_2	21.39
CaO	43.01
MgO	14.21
Na_2O	2.07
Fe_2O_3	2.52
Al_2O_3	14.81
P_2O_5	0.05
TiO_2	0.57
K_2O	0.83
SO_3	0.78

(1) As received basis
(2) Total ash basis

Table 14-12. REGENERATOR FUEL CHAR, RUN 14A

Run 14A

Date	10/28	10/29	10/29	10/29	10/29	10/30	10/30
Time	1830	0330	0430	1545	1845	1200	1930
Screen Size, Tyler Mesh	← Weight Percent →						
+35	7.3	4.7	4.0	6.7	6.3	33.2	23.9
34 X 48	12.5	3.6	0.9	2.4	1.8	3.9	4.5
48 X 65	2.0	7.0	3.0	8.9	9.3	3.7	5.1
65 X 100	4.4	12.9	9.2	20.0	20.3	4.8	6.2
100 X 200	34.0	23.0	25.4	26.9	28.7	12.9	13.1
200 X 325	13.1	27.5	34.0	29.6	22.8	33.2	22.3
-325	37.8	21.2	23.5	5.3	10.7	8.2	24.9
Ultimate Analysis, Wt %[1]							
CO_2	23.5	5.8	4.9	4.7	6.4	20.0	19.5
C	0.1	0.1	Tr	Tr	0.2	0.1	0.1
Ash	76.4	94.1	95.1	95.3	93.4	79.9	80.4
Elemental Analysis, Wt %[2]							
SiO_2	6.67	6.09	5.61	6.93	6.80	4.29	7.33
CaO	50.20		56.32	56.32		52.31	
MgO	36.65		33.76	34.00		37.93	
Na_2O	0.12	0.09	0.14	0.18	0.15	0.21	0.17
Fe_2O_3	1.68		1.08	1.08		1.69	
Al_2O_3	2.83		2.25	2.61		3.06	
P_2O_5	0		0	0		0	
TiO_2	0		0	0		0	
K_2O	0.37		0.20	0.43		0.29	
SO_3	1.04	0.97	0.92	0.02	0.26	0.59	0.67
Sulfide[1]			0.149	0.05			

[1] As received basis
[2] Total ash basis

Table 14-13. ASH AND ATTRITED ACCEPTOR, RUN 14A

Run 14B

Date	11/9	11/9
Time	1330	1630
Screen Size		
Tyler Mesh	Wt %	Wt %
+35	0.1	0.2
35 X 48	0.2	0.2
48 X 65	1.2	1.9
65 X 100	5.1	7.5
100 X 200	22.0	24.2
200 X 325	55.6	47.4
-325	15.8	18.7
Ultimate Analysis, Wt % (1)		
CO_2		18.1
C		2.5
Ash		79.4
Elemental Analysis, Wt % (2)		
SiO_2		6.91
CaO		53.40
MgO		33.71
Na_2O		0.16
Fe_2O_3		1.47
Al_2O_3		2.68
P_2O_5		0.02
TiO_2		0.12
K_2O		0.27
SO_3		1.10
Sulfide (1)		0.07

(1) As received basis
(2) Total ash basis

Table 14-14. ASH AND ATTRITED ACCEPTOR, RUN 14B

Run 14A

Date 10/31

Screen Size Tyler Mesh	Regenerator Dump Top	Regenerator Dump Middle	Regenerator Dump Bottom	Screen Size Tyler Mesh	Gasifier Dump Top	Gasifier Dump	Gasifier Dump	Gasifier Dump Bottom
	← Weight Percent →				← Weight Percent →			
+4	0.2	0.4	0.5	+6	0	0	0	0
4 X 6	2.0	4.3	5.0	6 X 8	1.2	1.4	24.6	15.6
6 X 8	7.7	11.6	13.1	8 X 10	3.2	2.9	11.7	13.7
8 X 9	8.8	11.7	12.1	10 X 14	8.7	6.1	13.3	18.6
9 X 10	12.2	15.0	13.4	14 X 20	13.8	9.2	10.4	15.8
10 X 12	11.3	12.0	10.6	20 X 28	17.7	14.4	10.4	13.2
12 X 14	13.1	11.6	11.2	28 X 35	16.4	19.1	9.9	9.1
14 X 16	10.1	8.6	8.4	35 X 48	14.8	21.4	9.8	6.8
16 X 20	9.3	7.7	7.8	48 X 65	11.7	14.6	6.0	4.1
20 X 24	6.1	4.7	4.9	65 X 100	7.8	7.6	2.9	2.2
24 X 28	6.1	4.5	4.9	100 X 200	4.5	3.2	1.1	1.0
-28	1.31	7.9	8.0	-200	0.2	0.1	Tr	Tr
Particle Density, Lb/Cu Ft	150	151	151		36.2	37.7	40.8	37.3
Percent Char					80	70	35	45
Activity		0.6						
Ultimate Analysis, Wt %(1)								
C					63.22	62.54	61.22	66.93
H					0.97	0.85	0.87	0.85
S					0.23	0.20	0.27	0.22
H_2O					0.13	0.08	0.07	0.11
Ash					22.14	22.81	23.00	22.32

Table 14-15. SOLIDS REMOVED AT SHUTDOWN, RUN 14A (Sheet 1 of 2)

Run 14A

Date 10/31

	Regenerator Dump			Gasifier Dump			
	Top	Middle	Bottom	Top			Bottom
		Dolomite		← Char Ash →			
Elemental Analysis, Wt %(2)							
SiO_2		5.75		16.24	19.17	23.38	16.52
CaO		52.85		45.54	44.12	39.22	44.85
MgO		37.80		15.68	14.50	13.47	15.77
Na_2O		0.09		1.94	2.30	2.80	2.16
Fe_2O_3		0.84		2.38	2.10	2.14	2.16
Al_2O_3		2.10		15.14	14.94	15.40	15.79
P_2O_5		0.03		0.05	0.05	0.05	0.05
TiO_2		0		0.58	0.48	0.54	0.55
K_2O		0.11		0.80	1.00	1.41	0.92
SO_3		0.42		0.96	1.16	1.18	1.45
Sulfide(1)		0.026		0	0	0	0

(1) As received basis
(2) Calcined basis or total ash basis

Table 14-15. SOLIDS REMOVED AT SHUTDOWN, RUN 14A (Sheet 2 of 2)

Run 14B

Date 11/10

Regenerator Dump				Gasifier Dump			
Screen Size Tyler Mesh	Top Weight Percent	Bottom Weight Percent	Screen Size Tyler Mesh	Top ← Weight Percent →			Bottom
+4	2.5	3.5	+6	0	0	0	0
4 X 6	11.8	13.1	6 X 8	0.6	3.7	1.5	3.7
6 X 8	17.4	16.6	8 X 10	2.0	5.7	4.2	9.0
8 X 9	10.3	9.3	10 X 14	7.3	17.4	12.4	19.5
9 X 10	11.3	11.0	14 X 20	13.4	25.0	19.2	22.0
10 X 12	9.0	9.0	20 X 28	19.8	23.6	22.7	19.8
12 X 14	9.6	9.9	28 X 35	18.5	10.9	16.7	11.8
14 X 16	7.3	7.5	35 X 48	15.8	6.6	11.5	7.3
16 X 20	6.7	6.6	48 X 65	10.6	3.5	6.3	3.8
20 X 24	3.7	3.6	65 X 100	6.9	2.0	3.4	1.9
24 X 28	3.1	3.0	100 X 200	4.6	1.4	1.9	1.0
-28	7.2	6.9	-200	0.3	0.2	0.2	0.1
Particle Density, Lb/Cu Ft							
Percent Char				72	40	45	30
Activity	0.23	0.25					
Carbonation Ratio	0.14	0.13					

Table 14-16. SOLIDS REMOVED AT SHUTDOWN, RUN 14B

Run 14B

Date 11/10

	Weight GM	ΔWeight GM	Overhead GM	Carbonation Ratio
As Received	107.00	-	-	.14
CO_2 Atmosphere	108.51	1.51	0.13	.17
N_2 Atmosphere	100.00	-8.51	0.25	0
CO_2 Atmosphere	120.68	20.68	0.08	.41

Assay at 1600°F in fluidized bed furnace

Reported as a weighted average of three screen fractions - 8 X 14M, 14 X 20M, and 20 X 28M

Table 14-17. THERMAL ASSAY OF REGENERATOR DUMP, RUN 14B

Run 14A

Date 10/31

	Below Regenerator Fuel Char Control Valve
Elemental Analysis, Wt %[1]	
SiO_2	5.54
CaO	55.64
MgO	35.45
Na_2O	0.10
Fe_2O_3	0.76
Al_2O_3	2.06
P_2O_5	0
TiO_2	0.02
K_2O	0.01
SO_3	0.83
Sulfide[2]	0.23
H_2O[2]	0.13
Calcine Weight Loss, %	9.7

(1) Calcined basis
(2) As received basis

Table 14-18. DEPOSITS, RUN 14A

RUN 15

DECEMBER 15, 1973 JANUARY 1, 1974

CO_2 ACCEPTOR PROCESS GASIFICATION

PILOT PLANT

RAPID CITY, SOUTH DAKOTA

1 SUMMARY

Run 15 was conducted from December 15, 1973, until January 1, 1974. The objectives for the run were to study the effects of using Velva lignite as a feedstock and to test the operation of the zinc oxide sulfur removal system. For these studies, the gasifier was operated with the regenerator isolated from the system.

Three feedstocks were used: Husky char; pre-oxidized Velva lignite; and raw Velva lignite. Heat and material balance data were gathered during steady-state periods for each feed. During these periods, the gasifier char bed was fluidized with steam and recycle gas. Since active acceptor was not circulated, enough air was injected to maintain the char bed temperature at about 1520°F.

These tests demonstrated that:

(1) With a 35 to 40 second vapor retention time and char bed temperature of 1520°F, all volatile material was cracked to methane, carbon oxides, hydrogen, and fixed carbon so that no tarry matter survived.

(2) No caking or particle swelling occurred when the system was operated on raw lignite feed.

(3) The mathematical model developed by Consolidation Coal Company predicted reasonably well the plant operation.

During the operation, the zinc oxide unit worked as expected. Recycle gas leaving the unit had consistently less than 2.0 PPM total sulfur even with inlet concentrations as high as 5,000 PPM. The gasifier recycle gas heater was normally operated in the range of 1500° to 1560°F. No evidence of iron-nickel sulfide blocking of heater tubes was observed.

After completion of the gasifier tests, the system was shut down for inspection and to reunite the gasifier and regenerator systems in preparation for Run 16. A large, highly-localized slag-like deposit was found covering the gasifier side flow distributor ring. This material was predominantly silica (80 percent SiO_2) and may have resulted from either ash fusion caused by high localized temperatures or by segregation and agglomeration of sand particles which contaminated the feed lignite. The high temperatures apparently resulted from the large air to steam ratio of the ring distributor gas. No evidence of deposits was found in either the boot or the char bed sections.

2 TEST DATA

Run 15 data are presented graphically and/or tabularly at the end of this run report. These figures and tables include:

		Page
Figure 15-1.	System Schematic	164
Figure 15-2.	Lignite Pretreatment Oxygen Consumption	165
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Table 15-2.	Gasifier Data, Run 15A	167
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Table 15-7.	Gasifier Char Overhead	172
Table 15-8.	Gasifier Transition Section Deposits	173

3 SIGNIFICANT EVENTS AND OBSERVATIONS

3.1 HISTORY OF RUN 15

3.1.1 Purpose

The objectives for Run 15 were to test the zinc oxide sulfur removal system and to study the effects of using Velva lignite as a feedstock. The survival of evolved tars and oils, particle swelling and caking tendencies, and gasifier deposit formation were of particular interest for the lignite tests.

3.1.2 Accomplishments

(1) Destruction of all evolved oils and tarry materials in the gasifier was accomplished at char bed temperatures of 1500° to 1525°F and vapor retention times of 35 to 40 seconds.

(2) Pre-oxidation of raw lignite feedstock to avoid particle swelling and caking was determined to be unnecessary.

(3) Gasifier char bed deposits of the type observed during bench-scale studies were avoided.

(4) Mild pre-oxidation of Velva lignite was accomplished by injecting air into the lignite preheater.

(5) Heat and material balance data were obtained while operating the gasifier using char, pre-oxidized Velva lignite, or raw Velva lignite as feedstocks.

(6) The new zinc oxide units were successfully put in service. This appears to have eliminated the sulfur corrosion in the gasifier boot recycle heaters.

3.1.3 Termination Cause

Following the completion of the gasifier tests, the plant was voluntarily shut down to prepare the unit for Run 16.

3.1.4 Mechanical Problems

(1) Plugging of the fines and oversize lines from the newly installed lignite scalping screen occurred throughout the run.

(2) During much of the run, high baghouse pressure drops caused periodic shutdowns of the lignite grinding system.

(3) Gasifier quench system drains occasionally plugged.

3.1.5 Process Problems

A highly-localized silica-rich deposit formed around the gasifier side flow distributor ring.

3.2 CHRONOLOGY OF OPERATIONS

Date	Time	Description
12/15	0830	Started pressuring up system.
"	1200	System up to pressure.
"	1530	Recycle compressors started.
"	2000	Process heaters lit.
12/16	0215	Started flow through zinc oxide towers.
"	0800	Replaced recycle to side flow of gasifier with steam.
"	1300	System up to temperature and lined out.
"	2030	Started zinc oxide tower test program.
12/18	1020	Started char feed to gasifier.
"	1930	Started air to gasifier side flow and reduced steam.
12/19	0335	Gasifier bed inventory complete, 25 foot bed.
"	1920	Out of ground char, gasifier holding on conditions.
12/20	0640	Started char feed to gasifier.
"	2000	Out of ground char, gasifier holding on conditions
"	2240	Started char feed to gasifier.
12/21	0000	Out of ground char, gasifier holding on conditions.
"	0110	Started char feed to gasifier.
"	0830	Blew gasket in FCV-2019. Steam replaced with recycle.
"	1015	Air flow to gasifier completely off.
12/22-12/26		Problems with char grinding in 100 area caused unreliable feed supply. Gasifier put on standby until problems were worked out in the 100 area.
12/27	1630	Started steam to gasifier side flow.
12/28	0745	Started air to gasifier side flow.
"	0900	Started lignite pretreating in preheater. (Char fed to gasifier from tote bins).
12/29	0100	Ended lignite pretreating in preheater.
"	0300	Started first char balance period.
"	0540	Ended first char balance period, started second balance period.
"	0800	Ended second char balance period.
"	1025	Started pretreated lignite feed to gasifier.
"	1045	B-207 heater (steam superheater) lit. (Was unable to use earlier because of removal of B-207-11A coil).
12/30	0050	Problems with plugging in quench system. Line to foul water stripper plugged. Belly drain on quench separator plugged.

Date	Time	Description
12/30	0525	Started first pretreated lignite balance period.
"	0545	Foul water stripper draining through sight glass to floor drain.
"	0755	Ended first pretreated lignite balance period, started second balance period.
"	1010	Ended second pretreated lignite balance period, started third balance period.
"	1100	Line from quench water separator to foul water stripper unplugged. Belly drains unplugged and open.
"	1205	Ended third pretreated lignite balance period, started fourth balance period.
"	1350	Ended fourth pretreated lignite balance period, started fifth balance period.
"	1557	Ended pretreated lignite balance period.
"	1813	Started feeding untreated lignite to gasifier.
12/31	0420	Started first untreated lignite balance period.
"	0645	Ended first untreated lignite balance period, started second balance period.
"	0800	Ended untreated lignite balance period.
"	1305	Out of ground lignite, gasifier on holding conditions.
"	1420	Started lignite feed to gasifier.
"	1900	Started third untreated lignite balance period.
"	2043	Ended third untreated lignite balance period, started fourth balance period.
"	2255	Ended untreated lignite balance period.
1/1	0745	Started plant shutdown procedure.

4 RESULTS AND DISCUSSION

4.1 BACKGROUND

Run 14 was abruptly ended when a tube ruptured in the regenerator air heater. An extended shutdown was scheduled in which the following major repairs were made:

(1) Coil replacement or repair in heaters, B-201-IA, B-201-IB, and B-203.

(2) Zinc oxide unit installation.

(3) Lignite grinding system scalping screen (Sweco) installation.

(4) Engager pot modifications.

After completing work on the gasifier system, Run 15 was conducted to take advantage of the time needed to complete the regenerator system repairs. For the run the gasifier was isolated from the system, pressurized, and heated to operating temperatures. Char and lignite were charged to the unit, gasified, and withdrawn. Since acceptor could not be circulated, the heat for the gasification reactions was supplied by burning char with air in the gasifier.

The primary objectives for the run were (1) to study the effects of using Velva lignite as a feedstock and (2) to test the operation of the zinc oxide sulfur removal system. The study was designed to determine if process modifications were necessary to convert from char to lignite feedstock. The conversion to lignite gasifier feed posed the following potential problems.

(1) Quench tower and back pressure control problems should volatile tars or oils escape the gasifier uncracked.

(2) Char bed agglomeration due to caking of raw coal.

(3) Loss of char bed inventory due to particle swelling.

(4) Deposits in the gasifier char bed section.

Based on Consol's early bench-scale studies, minor particle swelling and the survival of napthalene were expected to occur when lignite was fed to the system. However, these studies also demonstrated that only a 20 second average char bed vapor retention time at 1500°F was necessary to substantially hydrocrack all other volatilized materials. Therefore, the 30 to 40 second vapor retention time for the

run was conservative. The use of lignite feedstocks which are known to be non-caking assured that caking and coking would not occur. Finally, gasifier char bed deposits were not expected since a lignite with a low sodium content (about 1.4 percent of the ash) was used.

4.2 PROCEDURE

The system configuration is shown in Figure 15-1. Inert gas was used to pressurize the gasifier and zinc oxide systems. However, gas circulation through the zinc oxide towers was delayed until the inlet gas temperature reached 400°F to avoid water condensation. Then the towers were valved in and heated to an operating temperature of 700°F.

For the tests, three feedstocks were used: Husky char, Run 15A; pre-oxidized Velva lignite, Run 15B; and raw lignite, Run 15C. To establish the necessary char bed, Husky char was charged to the system first. Char feeding was from tote bins into the lockhoppers since the preheater was being used to pre-oxidize lignite for Run 15B. Steady-state conditions, with continuous char or lignite makeup and purposeful withdrawal of gasified char into F-213, were obtained during each run. Heat and material balance data were taken for these periods.

Turnover time between each run was necessary to replace the gasifier inventory with the next run's feedstock. Material was withdrawn into F-213 while fresh feed was charged to the gasifier to maintain the char bed level. Before a balance period was attempted, three nominal inventory changes were made.

4.3 PRE-OXIDATION

To determine what effect feed pretreatment would have on the swelling and caking tendencies of Velva lignite, the 15B feedstock was mildly pre-oxidized. The pre-oxidation was conducted in the lignite preheater. Initially, steam and hot flue gases from the preheater furnace were used to fluidize the lignite bed and to maintain preheater temperatures at 470° to 500°F. Gradually, the steam and air rates were increased while the fuel gas to the furnace was removed. The reaction between the air and the lignite was sufficient to maintain the preheater temperature. Table 15-1 shows the preheater conditions before the start of and during the pre-oxidation period.

Approximately 5 percent pre-oxidation (5 LB O_2/100 LB lignite) was attained. Oxygen and nitrogen balances around the preheater were used to determine the oxygen consumption. As shown in Figure 15-2, the rate of oxygen usage was relatively constant. Pre-oxidation continued 2-1/2 hours longer than expected due to problems with relighting the preheater furnace. The additional oxygen consumption was estimated to be 150 LBS.

4.4 ACCOMPLISHMENTS

Steady-state heat and material balance data were taken for each of the three runs. These data are shown in Tables 15-2, 15-3, and 15-4. In addition, the compositions of the feedstocks and the effluents from the system are shown in Tables 15-5, 15-6, and 15-7.

One pecularity to Run 15 was the difference in the ash compositions for the feed, overhead solids, and char bed materials. In previous runs, the overhead solids were significantly higher than the feed in silica content while the char bed solids were somewhat depleted in silica. The reverse is true for Run 15.

As in previous runs, the gasifier overhead solids were highly gasified. Typically, the fixed carbon burnoff was 58 to 66 percent based on the composition of the inlet feed.

No particle swelling and caking was observed for any of the three feedstocks. Neither was there any evidence that volatile oils or tars escaped the gasifier. This was to be expected since bench-scale studies indicated that a 20 second vapor retention time (based on average superficial gas velocity through the char bed at 1500°F) was required to destroy volatiles. For Run 15, the average vapor retention time was conservative and varied from 35 to 40 seconds. However, some naphthalene was expected to survive in the gasifier overhead gases when lignite was fed to the system even when char bed temperatures ranged between 1500° and 1530°F. None was ever found anywhere in the system including the naphthalene filters ahead of the recycle compressors. The Run 15 experience indicates that no system or major operating changes will be required when lignite is used as a feedstock in later runs; also, since particle swelling and caking are not problems, there is no need for the feed pre-oxidation step.

In early bench-scale studies conducted by Consol, char bed deposits were produced. Two distinct types are known: iron-rich deposits probably formed by the reaction of pyrites (FeS) with ash silica (SiO_2) and sodium silicate deposits which are probably formed by the reaction of sodium carbonate (Na_2CO_3) with silica. Following Run 15, no char bed wall deposits were discovered. These deposits were most likely avoided by using feedstocks which had low ash sodium contents. Typically, the ash sodium concentrations were 2.3 and 1.4 weight percent on a sulfur-free basis for the Husky char and the raw Velva lignite respectively.

The new zinc oxide sulfur removal system operated as expected. The absorber effluent gases contained consistently less than 2 PPM total sulfur even when the recycle gas to the unit had as much as 5,000 PPM H_2S.

The gasifier boot recycle gas heater was operated between 1500°F and 1560°F throughout the run. There were no problems with the heater operation nor was there any evidence of further iron-nickel sulfide corrosion.

4.5 PROBLEMS

The major mechanical problems encountered during the run were associated with the lignite grinding and gasifier quench system operations. Considerable effort was required to operate the grinding system with lignite as a feedstock. For the grinding system the two areas of concern were (1) high baghouse pressure drop and (2) the maintenance of reliable flow through the new screening system fines and oversize lines. The pressure drop problem was overcome by replacing the existing wool filter bags with ones made of Nomex. The new bags allowed higher temperature operation of the baghouse. This reduced the chances of bag blinding due to condensation when moist lignite was ground. To further improve operations, the recycle gas through the baghouse was minimized and the blow ring speed was increased for better bag cleaning. A comparison of the system operating conditions for grinding char and lignite is given below. Values are nominal for Run 15.

	Char	Lignite
Drying Furnace Outlet Temperature, °F	600/700	800/1000
Roller Mill Outlet Temperature, °F	300	350
Furnace Firing Rate, MM BTU/HR	1.5	2.7
System Oxygen Content, Mol %	5	5
Product Rate, LB/HR	6,075	1,575
Moisture Content, WT %		
Feed Solids	13	36-40
Product	3.8[1]	1-5

[1] Estimated

The firing control for the dryer furnace was revised by replacing the electronic controller with a pneumatic one and by replacing the liquid filled temperature sensor with a thermocouple. The electronic system failed because the liquid filled sensor leaked. This caused the furnace to fire harder due to the low indicated mill outlet temperature.

Prior to Run 15, a scalping screen (Sweco) was installed below the lignite cyclone which feeds the preheater. The purpose of the screen was to improve the quality of the gasifier feed by removing fines and recycling oversize material back to the mill. Operation of the fines and oversize lines from the screen was never completely satisfactory. This was primarily due to steam condensation in the lines which was aggravated by low ambient temperatures. Although the feeder below the

Sweco screen is purged with inert gas, steam still backs up from the preheater into the screen and causes line plugs. Some improvement was made in the operation of the oversize line. The line was relocated and a butterfly valve which restricted flow even when fully open was removed.

The quench system problems stemmed from solids plugs in the water circulation lines. Plugs formed in the line between the gasifier quench separator and the foul water stripper and between the foul water stripper and the organic waste pond. Because of these plugs, measurement of the gasifier overhead solids losses could not be made during most of the run. Reliable flow between the gasifier quench separator and the foul water stripper was obtained by replacing the caged trim valve in the line with a Vee-ball valve. Redesign of the quench system to further improve operation is being considered.

The only process problem for the run was discovered after the shutdown. A silica rich (80 percent SiO_2) deposit had formed over the gasifier side flow distributor. Significantly, the deposit was confined to the bottom of the transition section. No other deposits were found in either the boot or char bed sections.

The appearance of the deposit ranged from a light gray or tan colored grain-like agglomeration to a greenish-black dense fused material. Analyses of the materials (see Table 15-8) show that the deposit was chemically uniform throughout.

Apparently the formation of the deposit was partly due to high localized temperatures in the vicinity of the side flow distributor. This probably resulted from the low steam to air ratios used during the run. Other contributing factors may have been segregation of high silica fractions from the char or lignite feed or reactions involving the char ash.

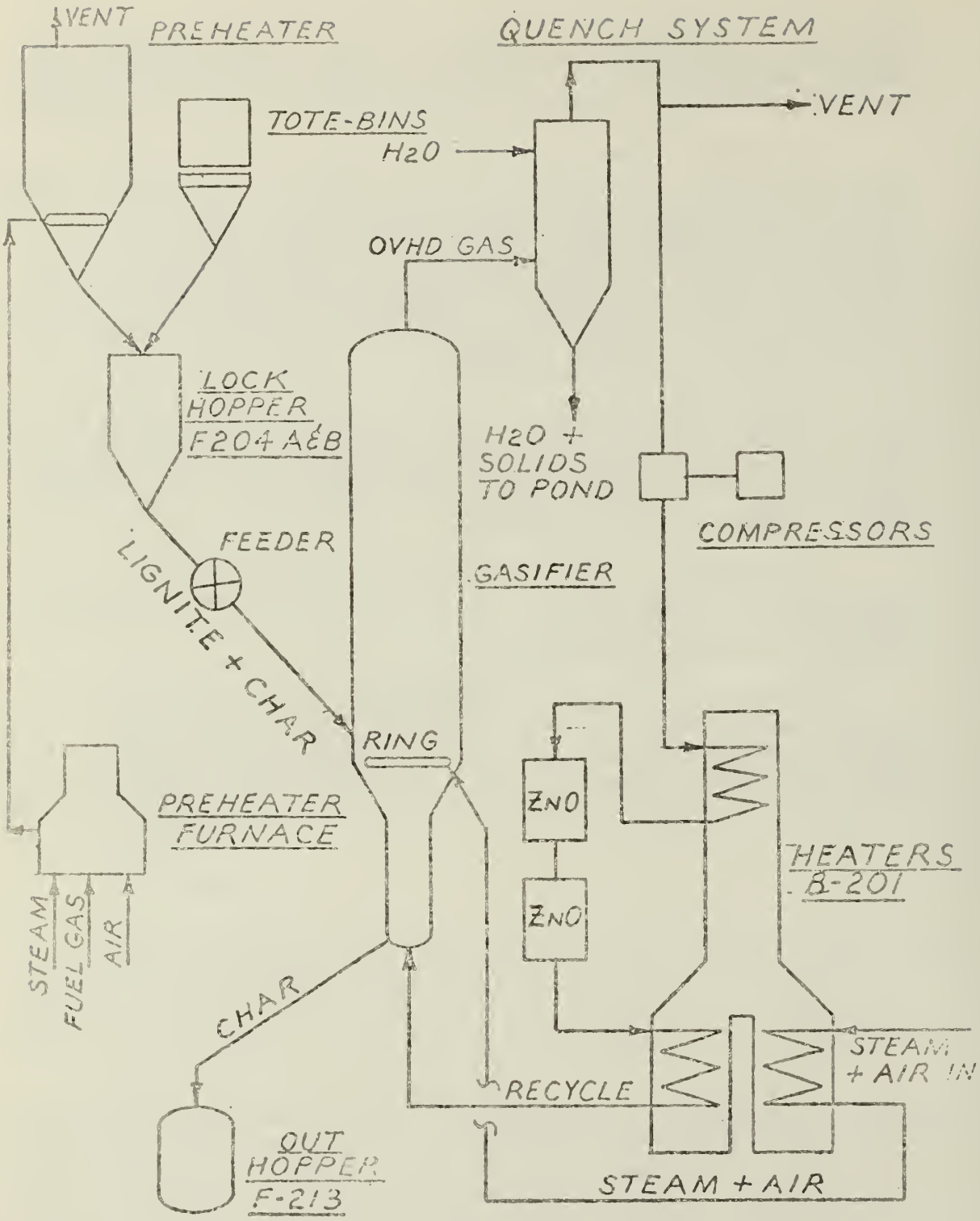

Figure 15-1. SYSTEM SCHEMATIC

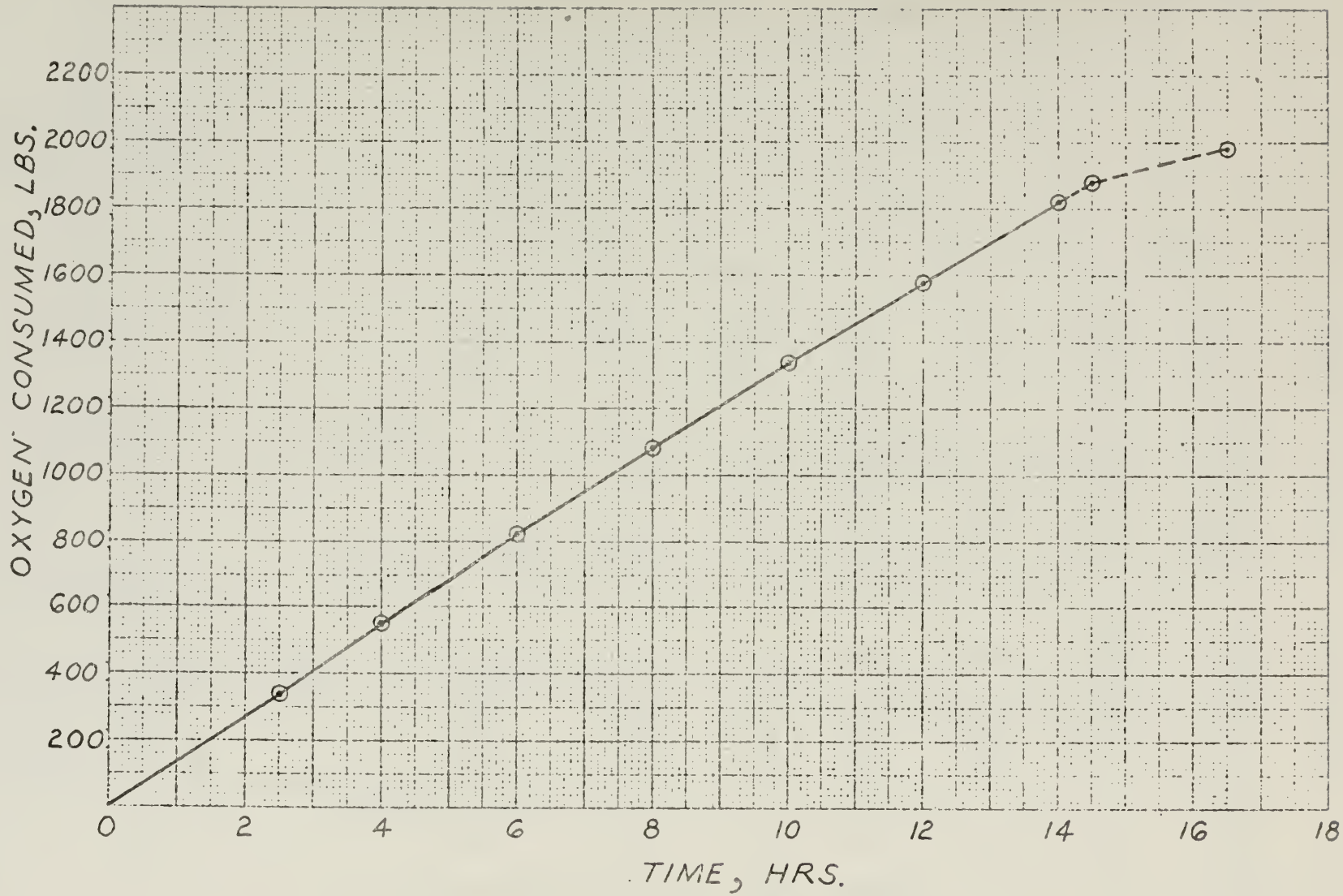

Figure 15-2. LIGNITE PRETREATMENT OXYGEN CONSUMPTION

Date	← 12/28/73 →						
Time	0815	0900	1300	1500	1700	1900	2100	2300
Lignite Charged to Preheater, lbs	36,600							
Bed Temperature, °F	470	480	490	490	490	485	485	485
Steam Flow, SCFH	50,400	73,200	73,200	73,200	73,200	73,200	72,400	72,400
Air Flow to Furnace, SCFH	7,800	11,100	11,250	11,250	11,250	11,100	11,040	11,100
Natural Gas to Furnace, SCFH	900	0	0	0	0	0	0	0
Furnace Outlet Temperature, °F	700	330	267	260	260	260	260	260
Dry Gas Analysis, Mol %								
In to Preheater								
O_2	0.45(1)	20.2	21.1	20.6	20.3	20.5	20.5	20.4
CO	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO_2	-	0.6	0.4	0.3	0.4	1.0	0.3	0.5
N_2 + Ar	-	79.8	78.5	79.1	79.3	78.5	79.2	79.1
From Preheater		(2)						
O_2	(3)	6.1	6.6	6.7	7.0	7.3	7.8	8.0
CO	(3)	0.8	0.8	0.8	1.2	0.7	0.7	0.7
CO_2	(3)	8.5	8.6	8.4	8.5	8.6	8.4	8.3
N_2 + Ar	(3)	84.6	84.0	84.1	83.3	83.4	83.1	83.0
O_2 Consumed, lbs		338.5	212.75	271.6	259.0	255.5	243.6	239.5

(1) Analyzer Reading
(2) 1130 A. M. Sample
(3) Not Sampled

Table 15-1. LIGNITE PRETREATMENT OXIDATION

Date	←		12/29/73		→
Time	0300	0400	0500	0600	0700
Jacket Steam Make, lb/hr	0	0	0	0	0
Solids					
Feed Stock	←		Husky Char		→
Feed Rate, lb/hr	778	778	778	879	879
Heating Value, Btu/lb	←		11,120		→
Dump to F-213, lb/hr	135	135	135	139	139
Overhead Solids, lb/hr	←		98		→
Gas Flows					
Boot (Recycle), SCFH	15,200	15,200	15,300	15,300	15,300
Steam to Side, SCFH	13,900	13,900	12,900	12,900	12,900
Air to Side, SCFH	19,800	19,800	19,800	19,800	20,100
Total Flow In, SCFH	48,900	48,900	48,000	48,000	48,300
Vent Rate, SCFH(1)	36,900	37,400	37,800	38,000	38,700
Purges					
Recycle, SCFH	←		3,500		→
Inert, SCFH	←		375		→
Vapor Retention Time, Sec(2)	37	36	36	36	37
Bed Conditions					
Boot Velocity, ft/sec	0.82	0.82	0.82	0.82	0.82
Char Bed Velocity					
Inlet, ft/sec(3)	0.54	0.54	0.52	0.52	0.52
Outlet, ft/sec(3)	0.70	0.71	0.72	0.73	0.72
Boot Density, lb/ft^3(4)	24	24	24	24	24
Char Bed Density, lb/ft^3(4)	27	27	27	27	28
Boot Temperature, °F	1525	1520	1515	1515	1515
Char Bed Temperature, °F	1530	1525	1520	1520	1505
Overhead Gas Composition, Mol %					
O_2	0.00	0.00	0.00	0.00	0.00
CO	16.80	16.40	16.00	16.00	16.00
CO_2	15.00	15.00	15.10	15.10	15.10
N_2	43.30	42.70	42.20	42.00	41.90
H_2	23.30	24.00	24.70	24.60	24.50
CH_4	1.60	1.70	1.90	2.30	2.50
H_2O MOL Fraction(5)	0.192	-	-	-	0.196

(1) Based on nitrogen balance

(2) Average vapor retention time in char bed based on inlet and exit gas velocities

(3) Velocity based on vent, recycle, and remaining steam rates. Steam rate based on water gas shift equilibrium

(4) Density indicated by pressure taps

(5) Gasifier overhead steam/wet gas ratio (measured)

Table 15-2. GASIFIER DATA, RUN 15A

Date	12/30/73										
Time	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600
Jacket Steam Make, lb/hr	0	0	0	0	0	0	0	0	0	0	0
Solids											
Feed Stock	Preoxidized Velva Lignite										
Feed Rate, lb/hr	1,060	1,060	889	889	889	991	991	942	1,025	1,025	1,025
Heating Value, Btu/lb	11,170										
Dump to F-213, lb/hr	100	100	184	184	184	104	104	137	99	99	99
Overhead Solids, lb/hr	(1)										
Gas Flows											
Boot (Recycle), SCFH	16,700	16,700	17,000	17,000	17,400	17,400	17,100	17,100	17,000	16,900	16,600
Steam to Side, SCFH	15,800	16,300	16,300	15,300	15,400	15,400	15,300	15,400	15,400	15,400	15,300
Air to Side, SCFH	21,000	20,200	20,900	21,100	21,100	21,000	18,800	21,200	21,100	21,000	21,000
Total Flow In, SCFH	53,500	53,200	54,200	53,400	53,900	53,800	51,200	53,700	53,500	53,300	52,900
Vent Rate, SCFH(2)	44,900	41,400	47,600	42,800	43,000	43,000	38,900	44,100	43,100	42,500	47,400
Purges											
Recycle, SCFH	3,500										
Inert, SCFH	375										
Vapor Retention Time, Sec(3)	36	38	38	37	36	36	39	36	36	37	37
Bed Conditions											
Boot Velocity, ft/sec	0.90	0.90	0.92	0.92	0.94	0.95	0.93	0.93	0.92	0.92	0.90
Char Bed Velocity											
Inlet, ft/sec(4)	0.58	0.58	0.59	0.59	0.59	0.59	0.56	0.59	0.59	0.58	0.58
Outlet, ft/sec(4)	0.78	0.74	0.77	0.76	0.77	0.77	0.71	0.77	0.77	0.76	0.75
Boot Density, lb/ft^3(5)	24	24	23	24	24	24	24	24	23	23	23
Char Bed Density, lb/ft^3(5)	27	27	26	26	26	26	26	25	25	25	25
Boot Temperature, °F	1510	1510	1530	1527	1528	1531	1532	1532	1532	1532	1530
Char Bed Temperature, °F	1507	1515	1528	1525	1525	1527	1527	1529	1530	1529	1525
Overhead Gas Composition, Mol %											
O_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO	19.90	19.10	19.40	19.70	19.70	19.70	20.40	20.80	20.40	19.90	20.10
CO_2	13.20	13.00	12.70	12.40	12.50	12.60	12.30	12.10	12.40	12.70	12.40
N_2	37.70	39.30	39.50	39.70	39.50	39.30	39.00	38.70	39.40	39.80	39.90
H_2	24.90	24.90	24.80	24.50	24.50	24.60	24.90	25.20	24.80	24.50	24.70
CH_4	4.40	3.60	3.60	3.70	3.80	3.80	3.50	3.20	3.20	3.10	2.90
H_2O MOL Fraction(6)	-	0.146	-	0.134	-	0.133	-	0.147	-	0.066	-

(1) Quench system trouble. Solids going to organic and solids settling ponds
(2) Based on nitrogen balance
(3) Average vapor retention time in char bed based on inlet and exit gas velocities
(4) Velocity based on vent, recycle, and remaining steam rates. Steam rate based on water gas shift equilibrium
(5) Density indicated by pressure taps
(6) Gasifier overhead steam/wet gas ratio (measured)

Table 15-3. GASIFIER DATA, RUN 15B

Date	12/31/73							
Time	0430	0600	0700	0800	1900	2000	2100	2200
Jacket Steam Make, lb/hr	0	0	0	0	0	0	0	0
Solids								
Feed Stock	Raw Lignite							
Feed Rate, lb/hr	1,117	1,117	1,440	1,400	1,293	1,293	1,273	1,273
Heating Value, Btu/lb	11,160							
Dump to F-213, lb/hr	192	192	140	140	221	221	409	409
Overhead Solids, lb/hr	(1)							
Gas Flows								
Boot (Recycle), SCFH	16,600	17,500	17,600	19,000	17,600	18,100	18,700	18,700
Steam to Side, SCFH	14,900	14,900	15,800	15,800	16,800	16,700	17,200	17,000
Air to Side, SCFH	23,100	23,100	22,300	21,900	21,600	21,600	21,600	20,000
Total Flow In, SCFH	54,600	55,500	55,700	56,700	56,200	56,400	57,500	55,700
Vent Rate, SCFH(2)	46,300	45,900	45,200	44,400	39,300	37,000	35,300	32,800
Purges								
Recycle, SCFH	3,500							
Inert, SCFH	375							
Vapor Retention Time, Sec(3)	35	35	35	35	38	40	40	40
Bed Conditions								
Boot Velocity, ft/sec	0.90	0.95	0.96	1.03	0.95	0.98	1.02	1.02
Char Bed Velocity								
Inlet, ft/sec(4)	0.60	0.61	0.61	0.62	0.61	0.62	0.63	0.61
Outlet, ft/sec	0.78	0.79	0.79	0.80	0.68	0.64	0.62	0.59
Boot Density, lb/ft^3(5)	23	23	23	23	24	24	24	24
Char Bed Density, lb/ft^3(5)	25	25	25	25	24	24	24	23
Boot Temperature, °F	1535	1535	1540	1534	1531	1532	1538	1543
Char Bed Temperature, °F	1530	1530	1535	1530	1522	1521	1531	1535
Overhead Gas Composition, Mol %								
O_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO	21.90	20.40	20.20	20.20	22.80	23.30	24.40	25.60
CO_2	10.90	10.50	10.40	10.40	9.60	8.00	6.50	6.40
N_2	40.10	40.50	39.70	39.70	44.30	47.00	49.30	49.20
H_2	23.10	25.00	26.10	26.10	20.40	18.50	16.70	15.60
CH_4	4.0	3.60	3.60	3.60	3.40	3.20	3.10	3.20
H_2O MOL Fraction (6)	0.129	-	0.154	-	0.071	(7)	(7)	(7)

(1)
(2) Quench system trouble. Solids going to organic and solids settling ponds
(3) Based on nitrogen balance
(4) Average vapor retention time in char bed based on inlet and exit gas velocities
(5) Velocity based on vent, recycle, and remaining steam rates. Steam rate based on water-gas shift equilibrium
(6) Density indicated by pressure taps
(7) Gasifier overhead steam/wet gas ratio
Apparatus probably frozen

Table 15-4. GASIFIER DATA, RUN 15C

Run	15A	15B	$15C_1$	$15C_2$
Date	12/29	12/30	12/31	12/31
Feed Stock	Husky Char	Preoxidized Lignite	Raw	Lignite
Screen Size Tyler Mesh	← Weight Percent →			
+6	0.0	0.0	0.0	0.0
6 X 8	0.0	0.0	0.0	0.0
8 X 10	1.4	0.0	Tr	Tr
10 X 14	15.5	1.2	7.1	4.3
14 X 20	26.0	9.2	14.0	7.8
20 X 28	19.7	15.7	17.2	12.0
28 X 35	13.0	18.4	16.6	14.7
35 X 48	10.4	20.7	16.3	18.8
48 X 65	5.4	15.3	12.0	16.4
65 X 100	2.1	9.7	8.2	12.7
100 X 200	2.4	5.8	6.2	10.6
-200	4.5	4.0	2.5	2.8
Particle Density, lb/cu ft	79.3	75.1	76.3	75.8
Ultimate Analysis, Wt %				
Moisture	2.49	0.0	0.0	0.0
C	71.84	66.96	65.79	66.24
H	2.46	3.70	4.74	2.79
N + O	(5.01)	(19.05)	(18.54)	(20.24)
S	1.66	0.49	0.71	0.71
Ash	16.54	9.80	10.22	10.02
Ash Analysis, Wt%				
SiO_2	29.45	25.95	27.23	27.16
CaO	22.36	28.44	26.01	27.47
MgO	8.12	13.86	15.04	13.84
Na_2O	1.82	1.06	1.27	1.23
Fe_2O_3	7.07	5.64	5.05	5.34
Al_2O_3	9.50	11.47	11.16	11.29
P_2O_5	0.02	0.12	0.08	0.03
TiO_2	0.37	0.56	0.25	0.09
K_2O	0.32	0.37	0.46	0.34
SO_3	21.65	13.80	12.87	13.89

( ) By difference

Table 15-5. FEEDSTOCK COMPOSITES

Run	15A	15B	$15C_1$	$15C_2$
Date	12/29	12/30	12/31	12/31
Feed Stock	Husky Char	Preoxidized Lignite	Raw	Lignite
Screen Size Tyler Mesh	← Weight Percent →			
+6	0.0	0.0	0.0	0.0
6 X 8	0.0	0.0	0.0	0.0
8 X 10	0.2	Tr	0.2	Tr
10 X 14	5.9	2.6	3.9	3.3
14 X 20	13.4	13.8	15.1	13.9
20 X 28	20.1	19.9	20.5	20.8
28 X 35	16.7	19.8	19.3	20.1
35 X 48	14.9	19.1	18.0	16.5
48 X 65	11.4	12.7	11.9	11.5
65 X 100	8.0	7.6	7.1	7.2
100 X 200	9.3	4.3	3.9	5.0
-200	0.4	0.3	0.2	0.4
Particle Density, lb/cu ft	50.3	48.2	53.8	53.1
Ultimate Analysis, Wt %				
Moisture	0.60	0.18	0.27	0.26
C	64.22	67.50	66.71	59.35
H	1.07	0.60	0.60	0.59
N	-	-	-	-
S	1.17	0.98	1.09	0.92
Ash	33.67	29.99	30.08	29.43
Ash Analysis, Wt%				
SiO_2	35.70	37.86	39.57	36.83
CaO	21.66	23.87	21.91	22.49
MgO	13.06	12.12	12.23	14.64
Na_2O	3.02	2.30	1.60	1.26
Fe_2O_3	3.56	3.42	4.50	5.23
Al_2O_3	13.59	12.75	11.72	8.67
P_2O	0.03	0.08	0.09	0.08
TiO_2	0.54	0.52	0.11	0.28
K_2O	0.61	0.54	0.46	0.39
SO_3	8.66	7.70	8.01	10.95

Table 15-6. GASIFIER CHAR TO F-213

Run	15A	15B	$15C_1$		$15C_2$
Date	12/29	12/30	12/31		12/31
Feed Stock	Husky Char	Preoxidized Lignite	← Raw Lignite →		
Ultimate Analysis, Wt %					
Moisture	(1)	28.56 (2)	0 (3)	0.85 (4)	0 (5)	0 (6)
C		9.79	59.08	55.26	66.53	73.19
H		2.79	1.00	0.89	1.76	0.80
N		-	-	-	-	0.40
S		0.87	1.23	2.39	1.33	0.71
Ash		59.83	31.97	35.88	27.49	20.43
Ash Analysis, Wt%						
SiO_2		19.45	25.10	23.26	38.31	26.10
CaO		56.52	38.17	36.71	18.10	30.07
MgO		8.69	7.20	5.82	6.92	9.36
Na_2O		0.35	1.25	0.90	1.29	1.62
Fe_2O_3		5.52	8.68	9.66	11.76	8.46
Al_2O_3		6.75	11.78	12.29	10.58	12.73
P_2O_5		0.06	0.16	0.10	0.05	0.13
TiO_2		0.49	0.74	0.69	0.64	0.70
K_2O		0.04	0.23	0.19	0.39	0.32
SO_3		2.97	8.65	11.25	12.27	10.73

(1) No Sample Taken
(2) Removed From Quench System
(3) Pond Sample
(4) Pond Sample
(5) Removed From F-319
(6) Removed From F-321

Table 15-7. GASIFIER CHAR OVERHEAD

Elemental Analysis	Deposit, Top Light Gray Granular	Deposit, Middle Gray Granular	Deposit, Bottom Blackish Slag
SiO_2	80.86	80.30	82.50
CaO	5.66	4.56	4.35
MgO	2.58	1.78	1.53
Na_2O	1.14	1.15	1.47
Fe_2O_3	3.73	3.21	2.63
Al_2O_3	5.80	5.70	6.48
P_2O_5	0.05	0.05	0.03
TiO_2	0.80	0.50	0.28
K_2O	0.33	0.31	0.98
SO_3	0.30	0.18	0.17

Table 15-8. GASIFIER TRANSITION SECTION DEPOSITS

RUN 16

JANUARY 14 TO JANUARY 23, 1974

CO_2 ACCEPTOR PROCESS GASIFICATION

PILOT PLANT

RAPID CITY, SOUTH DAKOTA

1 SUMMARY

Run 16 was initiated on January 14 and ended on January 23, 1974. Efforts were focused on maintaining the operability of the regenerator and the calcined acceptor return line. To improve the regenerator operation, a new startup procedure which used dead burned dolomite rather than an active acceptor as the initial regenerator inventory was tried. This procedure reduced the troublesome calcination step to a simple heating operation. After attaining operating temperatures (1830°F - 1850°F) in the regenerator, the dead burned dolomite was replaced with fresh active acceptor.

The new startup procedure was successful in eliminating regenerator deposits and in reducing the amount of regenerator bed fines. The use of nitrogen purges on the calcined acceptor return line, CD-206, coupled with the reduction in fines of the circulating acceptor, avoided the line scaling and plugging problem experienced in previous runs.

Totally integrated plant operation was maintained for 125 hours. During this period operations proceeded smoothly. Acceptor was continuously circulated between the reactors while gasifier char was used to fuel the regenerator. As the acceptor activity increased towards the end of the run, the air used to maintain the gasifier temperature was removed. Circulating acceptor then provided the necessary heat to sustain the gasification reactions. While air was still used in the gasifier, a four-hour balance period was obtained in which heat and material balance data were taken.

Due to the number and size of hot spots on the acceptor lift lines, CD-208, the decision was made to shut down. Inspection of this line and the engager pot revealed that severe erosion had occurred to the inner Incoloy 800 pipe. The erosion was highly localized, occurring primarily in the engager pot, at the two line slip joints and at one flange. The high lift gas velocities which often exceeded 85 FT/SEC for this run and the abrasiveness of the aged acceptor also contributed to the erosion problem.

The new zinc oxide sulfur removal system worked well in removing sulfur from the gasifier recycle gases. The total sulfur in the ZnO absorber exit gas was typically less than 1 PPM. Subsequent inspection of the new boot recycle gas heater coil showed no metal losses or evidence of sulfur attack.

Present plans are to modify the acceptor lift line and the engager pot to reduce acceptor attrition and erosion. The startup procedure

for Run 17 will incorporate the use of dead burned dolomite as in Run 16. Also, to further reduce acceptor lift line erosion, some recycle gas will be diverted to the regenerator air line. The lift gas velocity will be limited to 50 FT/SEC.

2 TEST DATA

Run 16 data are presented graphically and/or tabularly at the end of this run report. These figures and tables include:

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3 SIGNIFICANT EVENTS AND OBSERVATIONS

3.1 HISTORY OF RUN 16

3.1.1 Purpose

The purpose of the run was to test the possibility of using dead burned dolomite as a startup material. Since the dead burned dolomite is rugged and is inactive towards reaction with carbon dioxide, its use during the startup was expected to reduce the amount of regenerator bed fines, minimize the chances of forming regenerator deposits and improve the reliability of the calcined acceptor return line, CD-206, operation.

3.1.2 Accomplishments

(1) Obtained additional data for correlating solids circulation rate as a function of flow control valve position.

(2) Established continuous solids circulation between reactors while showering acceptor through the gasifier char bed.

(3) Established and maintained char combustion in regenerator.

(4) Operated the regenerator at calcining conditions, 1830°F - 1850°F, while circulating stone and replacing dead burned dolomite with active acceptor.

(5) Removed air from the gasifier and maintained char bed temperature by circulating active acceptor.

(6) Operated the regenerator without the formation of deposits and reduced the amount of fines in the calcining acceptor bed.

(7) Eliminated loss of acceptor circulation due to plugging of calcined acceptor return line.

(8) Eliminated sulfur corrosion in the gasifier recycle heater.

(9) Obtained heat and material balance data.

3.1.3 Termination Cause

The decision was made to shut down when the hot spots on the acceptor lift line became worse and more numerous. Later investigation revealed that the inner Incoloy pipe had eroded away in several areas.

3.1.4 Mechanical Problems

(1) During startup one tube pass in the regenerator air heater, B-203, became partially plugged with dolomite.

(2) Filter bags in the char grinding system baghouse were burned when the baghouse temperature became excessive.

(3) The new flue gas quenching device plugged and became inoperable.

(4) The bottom regenerator temperature probe broke.

(5) Erosion of the acceptor engager pot internals was excessive.

3.1.5 Process Problems

The gasifier acceptor showering inventory apparently became intolerably high.

3.2 CHRONOLOGY OF OPERATIONS

Date	Time	Hours	Description
1/14	0945		Started to pressure up unit
"	1300		Gas circulation started and process heaters lit
1/15	0230		Started steam to gasifier side flow, removed recycle
"	0530		Started flow through Zinc Oxide towers
"	1500		System up to temperature
"	2235		Started feeding dead burned dolomite to system
1/16	1145		Dead burned dolomite inventory complete
"	1335		Started acceptor circulation, running circulation tests
"	2320		Started feeding char to system
1/17	0540		Started air to gasifier side flow
"	1145		Gasifier char bed level filled to operating level of 21 feet
"	1215		Started acceptor circulation at 7 PSI loading on TCV-2030
"	1230		Reducing temperature on B-203 and B-204 heaters
"	1245		Started dead burned dolomite makeup to regenerator at 1 RPM on L-204 feeder
"	1340		Increased L-204 feeder rate to 2 RPM
"	1430		Raised air and adjusting steam to 20,000 SCFH air and 25,000 SCFH steam
"	1445		Sheared pin on L-204 feeder. Shut down feeder and prepared to fill F-206

Date	Time	Hours	Description
1/17	1530		Transferred char to regenerator for 10 minutes to keep line clear
"	1630		Started burning natural gas in regenerator
"	1830		Tried to initiate char combustion in regenerator, would not transfer
"	1850		Lost acceptor circulation through TCV-2030
"	1920		Regained acceptor circulation
"	1935		Began char combustion in regenerator. Char flow erratic
"	2115		Methane burning in regenerator stopped
"	----		Tried to grind char for the last few hours Continuous problems with Sweco screen, and fines and oversize lines from the Sweco plugging
"	2135		Out of ground char. Char transfer to regenerator stopped. Air out of gasifier and regenerator
"	2200		Acceptor circulation through TCV-2030 stopped
"	----		Maintenance worked several hours to unplug line to F-213
1/18	0000		Finally cleared by blowing into gasifier
"	0010		Inert gas flow out, started air to gasifier
"	0015		Started natural gas to regenerator
"	0047		Unplugged oversize char line on ninth floor, started to grind straight to lockhopper
"	0107		Started acceptor circulation through TCV-2030
"	0120		Started char feed to gasifier
"	0128		Increased air to gasifier
"	0300		Air and char to regenerator
"	0430		Char feed to regenerator erratic Series of events: - Problems with char transfer to regenerator - Char lift line plugged - Flow backed up through gasifier - Decreased flows to try to regain interface
"	0530		Interface regained
"	0538		Circulation back. Started natural gas and air to regenerator
"	0730		Problems with J-309 compressor. Natural gas and air out of regenerator and air out of gasifier momentarily
"	0810		Started char transfer to regenerator
"	0835		Char feed lost for about two minutes
"	0845		Started dead burned dolomite makeup at 1 RPM. System lined up to F-213 to withdraw dolomite
"	1045	0	Regenerator at 1875°F, gasifier at 1500°F
"	1230		Fine tuning flows Closed 2-inch bypass around HPC system. J-207A compressor shut down

Date	Time	Hours	Description
1/18	1310		Low level in dolomite hopper. Refilling with fresh 6 X 9 dolomite. Dumping F-213
"	1315		Lost char feed to gasifier for about one-half hour
"	1400		Lost char transfer to regenerator
"	1415		Switched purges on line CD-206 to nitrogen
"	1515		J-203A compressor shut down, no apparent reason. Started back up
"	1520		Reestablished char transfer
"	1638	5.9	Started dolomite makeup to regenerator
"	1830		Stopped dolomite makeup. Line to F-213 plugged. Regenerator level increasing
"	1848		Line to F-213 cleared
"	1850		Dolomite makeup resumed
"	1900		Set point on regenerator oxygen analyzer drifting
"	2120		LCV-2003 hung open twice. Checked out and no problem from hereon
"	2130		Found hole in "C" gas dryer inlet filter. By-passed dryers. FR-2015 became erratic
1/19	0630		Low level in dolomite hopper
"	0700		Refilling dolomite hopper and dumping F-213
"	0845		Started dolomite makeup to regenerator
"	1130		Closed ball valve above F-213 to stop leakage through LCV-2073 so level could be increased in regenerator.
	NOTE:		It was discovered after the shutdown that the butterfly on SCV-2073 had broken loose so it had no control at all
"	1230		Increased flue gas flow through regenerator overhead venturi
"	1510	28.4	Increased dolomite makeup from 1 to 1.5 RPM
"	1600		Opened valve to F-213
"	1745		Line to F-213 unplugged
"	1900		Recharged F-206 and dumped F-213
1/20	0510		Found hole in 100 area cyclone on tenth floor. Maintenance called out.
"	0545		Low level in F-206. Recharging F-206 while dumping F-213
"	0620		Started dolomite makeup. Opened to F-213
"	0825		Shut down J-207B compressor
"	0915	46.5	Increased acceptor circulation from 7 to 7.5 PSI loading on TCV-2030
"	1000	47.2	Removed natural gas from regenerator
"	1030		Started bypassing HPC system
"	1400	51.2	HPC system completely out of service
"	1535		Recharging F-206, dumping 213
"	1815	54.5	Jim Dandy plugged. No movement on "spider." All flow through venturi
"	2025	57.7	Lowering B-205 heater to 1200^{o}F due to hot spots on lift line

Date	Time	Hours	Description
1/20	2140	58.9	Lowered B-205 heater to 1025°F
1/21	0015		High level in regenerator quench tower. J-203A recycle compressor suction pressure dropping
"	0135		Recharged F-206 and dumped F-213
	NOTE:		
"	0400		Breakthrough of H_2S from first Zinc Oxide tower
			Regenerator quench tower drains unplugged. System back to normal
"	0635		Dolomite circulation through TCV-2030 almost quit. Stroked valve and kept flow going
"	1240		Refilling F-206 and dumping F-213
"	1830		Refilling F-206 and dumping F-213
"	2000		Lost TE bundle in bottom of regenerator
"	2000		Started first 4-hour balance period
1/22	0000		Ended first balance period, started second
"	0020		First Zinc Oxide tower removed from service in preparation to change out catalyst
"	0300	88.2	LIC-2001 raised to increase regenerator level
"	----		Problems with dPR-2077 (regenerator bed) dPCV-2030 on manual and FI's checked. Developed a fluctuation on the system which affected char transfer and therefore temperature. Pressure problem seemed to originate on regenerator side of system
"	0545		Refilled F-206 and dumped F-213
"	----		PCV-2071 out of control with both control valves and bypass open
"	0800		Instrument department working on FRC-2021. Seal did not hold and FCV-2021 went open causing high steam flow in gasifier
"	1000		Oxygen breakthrough in regenerator. High temperature and problems with char transfer to regenerator
"	1010		Closed ball valve above F-213
"	1013	95.5	Increased circulation to 8 PSI on TCV-2030
"	1015		FRC-2113 (air to regenerator) went out of control and caused an upset in temperatures and CO control. Sensing line to transmitter was found frozen
"	1020/1400		Worked on getting temperature and CO back under control. Used natural gas to line out system
"	1500		Dumping Zinc Oxide tower
"	1530	100.7	Increased acceptor circulation to 9 PSI on TCV-2030
"	1600	101.2	Natural gas out of regenerator
"	1600	101.2	Raised valve loading on TCV-2030 to 10 PSI
"	1645		Filling F-206 and dumping F-213
"	1650		Air out of gasifier
"	1700		Air back to gasifier

Date	Time	Hours	Description
1/22	1740	102.9	TCV-2030 loading increased to 11.5 PSI
"	1835		Air out of gasifier
"	1900	104.2	Increasing char level in gasifier to 25 feet
"	1920		Small amount of air back to gasifier
"	2003		Slight oxygen breakthrough in regenerator
"	2045		Zinc Oxide tower back in service
"	2100		Boot flow decreased to give a nonfluidized bed. Helped to reduce bed density
"	2306	108.3	Loading on TCV-2030 to 11.75 PSI
1/23	0230	111.75	Loading on TCV-2030 to 12 PSI
"	0300		Filled F-206 and dumped F-213
"	0310		Air out of gasifier
"	0330		Started regenerator flue gas to the preheater
"	0345	113	Loading on TCV-2030 to 12.5 PSI
"	0400		Small amount of air to gasifier
"	0430	113.7	Loading on TCV-2030 to 13 PSI
"	0445		Reduced air to gasifier
"	0555	115.2	Air out of gasifier
"	0630	115.7	Loading on TCV-2030 to 13.5 PSI
"	0925	118.7	Increased dolomite makeup from 1.5 to 2 RPM.
"	1030		Level low in regenerator. Starting to affect overhead transfer
"	1215		Pressure increased on regenerator. Reduced lift gas and sent more flue gas to preheater
"	1230		Switched from dPCV-2030-1 to dPCV-2030
"	1235	121.8	Dolomite makeup back to 1.5 RPM
"	1330		Pulled dPCV-2030-1 valve. Air signal leaked off and closed dPCV-2030. Regenerator pressure increased. Closed XCV-2010, TCV-2030, LCV-2002, and LCV-2003
"	1400		Started to bring system back. Switched back to dPCV-2030-1
"	1405		Air back to gasifier
"	1430	123.7	Decided to shut down due to condition of hot spots throughout system

4 RESULTS AND DISCUSSION

4.1 BACKGROUND

Regenerator deposits and plugging of the calcined acceptor return line, CD-206, plagued operations during many runs prior to Run 16. Agglomeration of acceptor fines appeared to be responsible for the regenerator deposits and the scale which often coated the walls of CD-206. Additionally, excessive amounts of acceptor and char ash fines in the circulating acceptor often caused bridging and loss of acceptor flow through CD-206. Normally, operations proceeded smoothly until the regenerator inventory was calcined. At that point the amount of fines in the inventory increased dramatically. This was due to acceptor attrition because of the stone's softness. As the acceptor cycles between the calcined and recarbonated conditions, it ages and hardens. Attrition losses become minimal and the ability of the regenerator bed to cleanse itself of fines via stripping is improved.

For Run 16 the startup procedure was modified to eliminate the initial calcination step in which the entire regenerator inventory is composed of fresh, soft acceptor. The technique was to start up with an inert material which could be directly heated to the acceptor calcining temperature. Then this material was gradually replaced with fresh acceptor. This procedure assured that only a small amount of fresh acceptor existed at any time in the regenerator bed. Thus, as the materials were interchanged, the circulating acceptor was composed of material with a spectrum of ages and hardnesses.

To further improve the operation of the calcined acceptor return line, the recycle gas purges to the line were changed to nitrogen. This was done based on the results of tests conducted by Consolidation Coal Company's Research Department. In these tests, $CaCO_3 \cdot CaSO_4$ mixtures were determined to form melts at temperatures as low as 1400°F. By eliminating the CO_2 in the purge gases, no acceptor recarbonation, which would produce sticky fines, would occur.

In the preceding Chronology of Operations Section (paragraph 3.2), the timing of significant events are shown under the heading "Hours." Zero hours for the run corresponds to the time when the regenerator attained operating temperature. Other important times include:

(1) The start of fresh acceptor makeup, 6 hours.

(2) The time when evidence of acceptor lift line erosion appeared, 58 hours.

(3) The time the gasifier operation was sustained without the use of air, 115 hours.

4.2 ACCOMPLISHMENTS

Run 16 was the fourth run in which significant heat and material balance data were taken. Probably the most important achievement of the run was the successful execution of the new startup procedure which allowed the plant to be brought on stream smoothly. By using dead burned dolomite to initially fill the regenerator, the new procedure insured that only a small amount of fresh active stone existed in the system at any given time. This reduced the amount of fines in the regenerator inventory and in the circulating acceptor. As a consequence regenerator deposits and plugging of the calcined acceptor standleg were both eliminated. During the run, oxygen breakthrough was experienced on several occasions for a total time of about one hour. Apparently, since the acceptor had aged and hardened, no agglomeration due to transient liquid formation occurred.

During Run 14, special acceptor circulation tests were conducted to obtain a correlation between the flow control valve, TCV-2030, setting and the acceptor flow rate. The tests were made using half-calcined dolomite which had a particle density of 127 LB/CU FT. To confirm these data, similar tests were conducted during Run 16 using dead burned dolomite which had a particle density of 202 LB/CU FT.

The Run 16 circulation test procedure was somewhat more dynamic in nature than the one used in Run 14. However, similar results were obtained in both cases. For Run 14 the solids circulation was stopped, then the gasifier boot inventory was drained to a low level. With the boot level control valve, LCV-2003 closed, TCV-2030 was opened a specific amount and the time required to fill the gasifier boot was recorded. The bed level was determined by differential pressure measurements. The Run 16 procedure consisted of draining the boot inventory to a low level while circulating acceptor at a given valve loading on TCV-2030 and then recording the time required to fill the boot after LCV-2003 was closed.

System conditions during the tests are given in Table 16-1. Figure 16-1 shows the correlation obtained between mass flow rate and TCV-2030 valve air loading. Again as in Run 14, the data appear to be precise since there is little scatter.

To obtain a common basis for comparing the results of the two tests, the volumetric flow rates are plotted in Figure 16-2. As shown, the half-calcined dolomite flow rates are within ±20 percent of those for the dead burned stone for valve loading between 8 and 14 PSI.

Run 16 also provided a 4-hour balance period in which the system was operated at steady state conditions. Data obtained during this period are being processed by Consol in Library, Pennsylvania, to provide additional heat and material balance information. Table 16-2 shows the

system conditions for the balance period. This table also shows system conditions early in the run and conditions near the end of the run when all the air was removed from the gasifier. Additional data for feed, effluent, and dump materials are contained in Tables 16-3 to 16-10.

Finally, the new zinc oxide system appears to have eliminated sulfur corrosion in the gasifier boot heater, B-201-IA. Total sulfur in the zinc oxide exit gases was always less than 5 PPM and normally less than 1 PPM. Carbonyl sulfide was the only sulfur species detected in the absorber exit gases. Following the run, ultrasonic inspection of the B-201-IA heater coil showed no metal losses. Also, inspection failed to show any metal losses in the new Incoloy 800 heater coils for the gasifier side flow heater, B-201-IB, or the regenerator air heater, B-203.

4.3 PROBLEMS

Operations proceeded smoothly throughout most of Run 16. Only minor equipment problems were experienced. The most serious are listed below:

(1) The new Nomex bags in the lignite grinding system baghouse were scorched and developed holes. The actual damage to the bags was apparently done during Run 15 when lignite was ground and the baghouse temperature exit became excessive. Plans are to install thermocouples and to record temperatures in the baghouse.

(2) Early in the run, one tube pass in the regenerator air heater plugged. During shutdown the restricted tube pass was cut open and the dolomite plug removed. This material had apparently been in the line to the heater or in the header since Run 14.

(3) Plugging of the new flue gas quenching device continued to be a problem. Eventually the device jammed so that the internal shaft could not be rotated or moved vertically. The adherence of solids to the internal shaft may have resulted from the failure of the shaft shaker early in the run. The pneumatic shaker was inoperable because the actuating gas regulator was plugged. Although the new quenching device failed, the parallel venturi operated satisfactorily. Inspection of the venturi showed no solids buildup and only a thin (less than 1/4 inch thick) solids scale on the downstream piping.

(4) Erosion of the engager pot internals and the acceptor lift line was the most serious equipment problem encountered in the run. Severe erosion of the engager pot internals occurred at the spent acceptor inlet, fresh acceptor inlet, and at a point between the two acceptor inlets. Erosion of the lift line

occurred at the two internal slip joints and just downstream of the middle flange joining the two pipe sections. The primary causes for the erosion were:

a. The hardness of the aged acceptor.

b. The high lift gas velocities used.

c. The design of the internal expansion joints.

d. Pipe misalignment at the middle flange.

Prior to the run, the engager pot was modified to reduce the attrition of the circulating acceptor. Because of the severe erosion which occurred in the engager pot, it will again be modified. The new design will be similar to that used originally. The major modification will be to allow sufficient room in the bottom to maintain a one-foot deep fluidized bed of acceptor. The fluidized bed should dissipate some of the inlet gas energy as it lifts the acceptor. This in turn should keep acceptor attrition low at the pickup point.

(5) The major process problem encountered during the run was the high char bed density due to acceptor retention. As the acceptor circulation rate was increased, the boot gas velocity had to be reduced to keep the showering inventory from increasing. Under these conditions the boot acceptor inventory was not fluidized, and although char stripping was adequate, a small amount of char remained with the spent acceptor. The disadvantage of this type of operation is that the acceptor level cannot be accurately determined using pressure taps. This is because the pressure drop through a nonfluidized bed is proportional to the gas velocity and not constant as it is for a fluidized bed.

4.4 ACCEPTOR ACTIVITY

Replacement of the inactive dead burned dolomite with fresh acceptor was begun approximately six hours after the regenerator was operating at calcining conditions. As shown in Figure 16-3, the nominal acceptor makeup rate was 450 LB/HR throughout most of the run. The acceptor activity behavior is also shown in the figure. As expected, the activity generally increased as the dead burned material was replaced. An activity plateau existed from 80 to 110 hours into the run. Then the activity again increased until the end of the run.

The activity plateau may have been the asymptotic limit due to the low circulation rate maintained throughout most of the run. Analysis of the run data indicate that the rate was only 1600 to 2000 LB/HR. Low circulation rates mean long residence times at high temperatures for the acceptor in the regenerator. This is known to cause acceptor

deactivation. Therefore, the increase in acceptor activity towards the end of the run may have resulted from the increased acceptor circulation. During the last day of operation, the circulation rate was increased and probably exceeded 15,000 LB/HR.

4.5 CARBON BURNOFF

Carbon burnoff occurs in both reactors. In the regenerator the carbon is burned with air to supply the calcination heat requirements. As shown in Table 16-9, essentially 100 percent of the char carbon was consumed.

In the gasifier, the carbon burnoff results from the gasification reactions and from combustion while air is used to maintain reactor temperatures. Preliminary heat and material balance calculations indicate that approximately 45 percent burnoff was obtained during the balance period.

4.6 GASIFIER OVERHEAD SOLIDS LOSSES

At operating conditions some char is carried out of the gasifier with the overhead gases. This material is removed from the gases in the gasifier quench system and is eventually discharged into the organic quench water pond. These char losses are significant and must be considered for heat and material balance calculations.

In Figures 16-4 and 16-5, the gasifier char feed rate and the overhead char losses are shown. The char feed rates were averaged over the 4 to 6 hour period needed to dump three lockhopper charges. This was done to help smooth the feed rate data. Because of fewer data, the gasifier overhead solids losses are point values. The char losses were determined from the solids content of the water discharged to the organic pond and are values for given times. The gaps in the char loss data indicate periods when samples were not taken. However, one nonrepresentative data point which was excessively high was ignored for the period 0400 HRS, 1/19/74. Based on these data the overhead char losses average 11 to 12 percent of the char feed.

5 FUTURE PLANS

Prior to Run 17 the lift line and the engager pot will be repaired and modified. The bell-shaped lift line expansion joints will be replaced with joints having a 2.4 degree taper. The increased tapered length should provide a smooth transition for the flow of gases and solids as they pass from one pipe section to another.

As mentioned earlier, the engager pot will be modified to allow the incoming solids to fall into a one-foot deep fluidized bed. The solids will remain in the fluidized bed for a brief period and then be lifted to the regenerator. The new design is expected to reduce both the acceptor attrition and the internal erosion of the lift station. To further reduce lift line and engager pot erosion, the lift gas velocity will be limited to 50 FT/SEC.

Plans for the startup are to proceed in a manner similar to that for Run 16. The available dead burned dolomite will be used to initially fill the regenerator. Any additional material required for the filling will be made up from the 16 X 32 mesh fraction of the Run 16 spent acceptor. This material is aged, hard and should not present any fines generation problem in the regenerator.

A systematic stepwise procedure will be followed with the ultimate goal of achieving an equilibrium acceptor activity of 0.35 and the complete removal of air from the gasifier. Acceptor circulation will be maintained at 11,000 to 12,000 LB/HR and the gasifier carbon burnoff will be targeted for 56 percent. This should improve acceptor showering so that a large showering inventory does not accumulate. Present calculations indicate that at least 150 hours of operation from the time fresh acceptor makeup is initiated will be required before the target conditions are met.

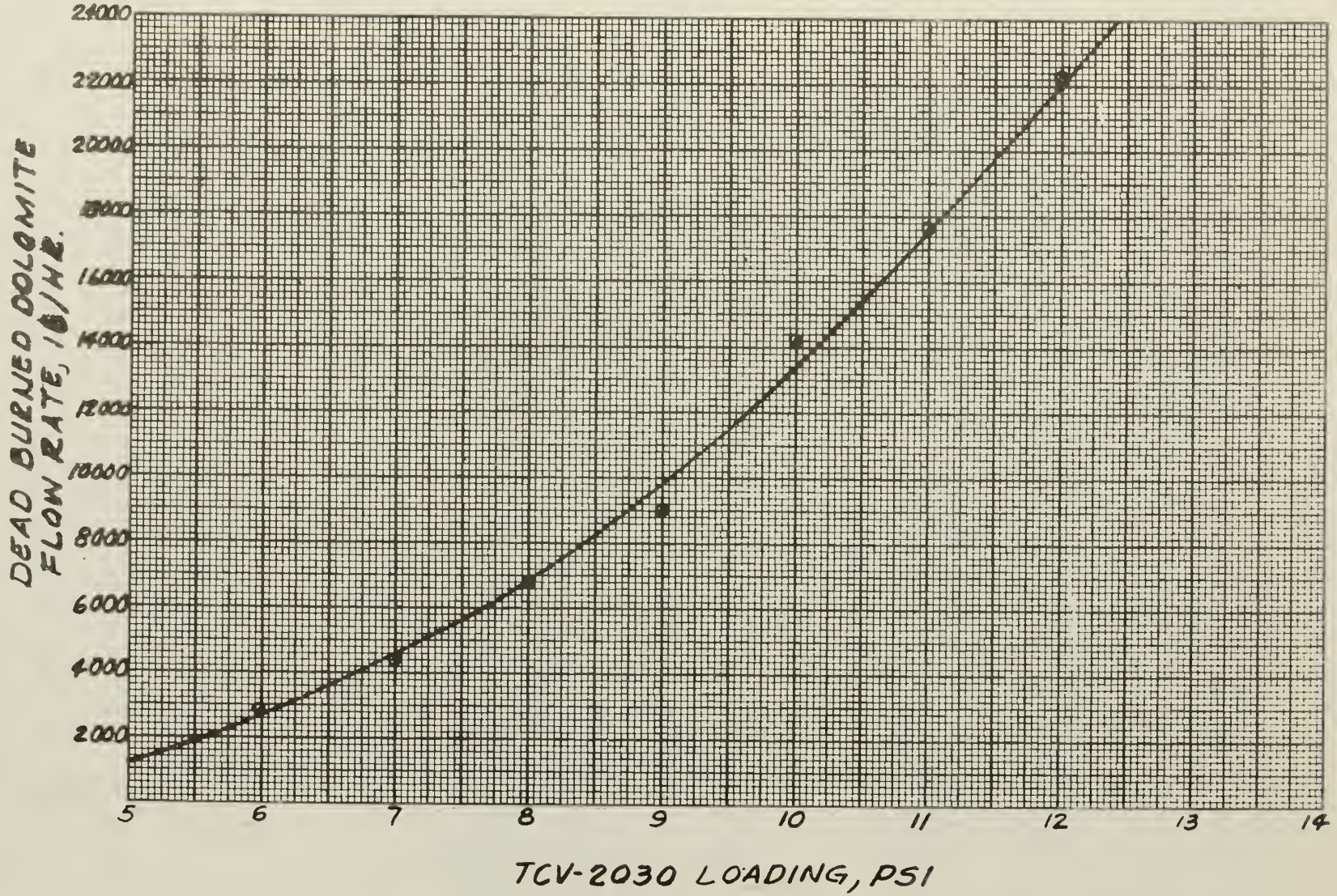

Figure 16-1. DEAD BURNED DOLOMITE CIRCULATION RATE

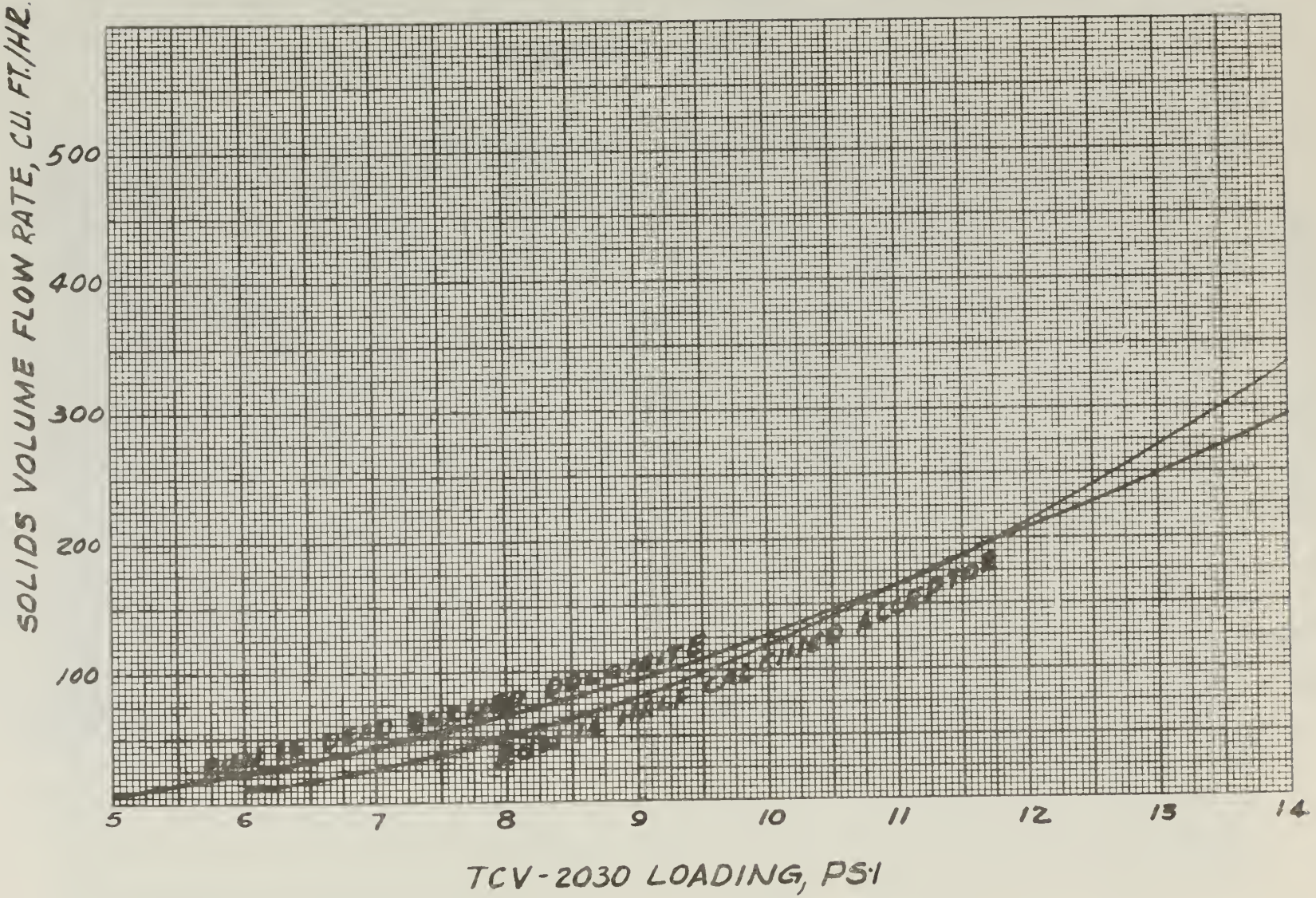

Figure 16-2. SOLIDS FLOW RATE COMPARISON

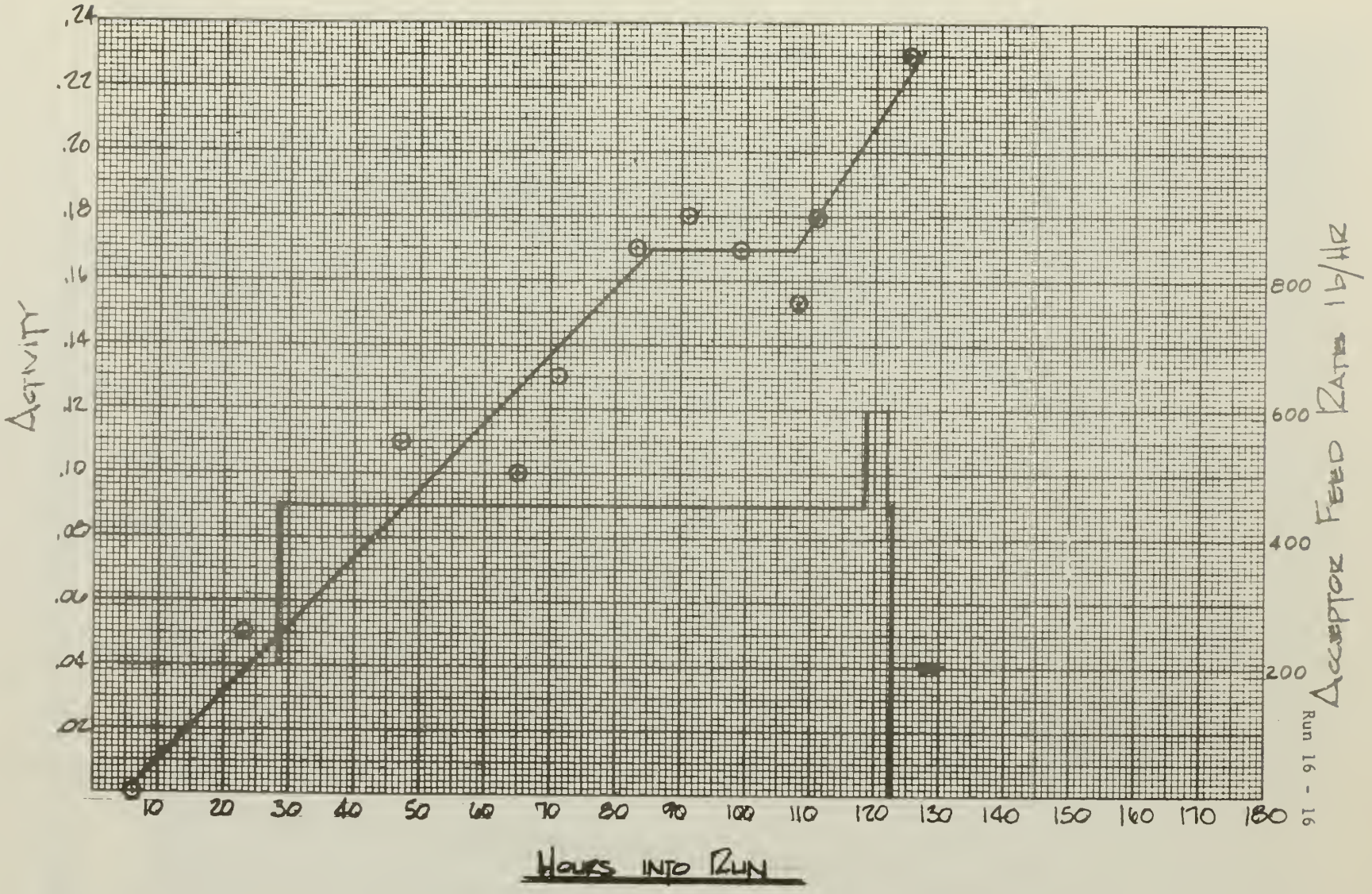

Figure 16-3. ACCEPTOR ACTIVITY AND FEED RATE, RUN 16

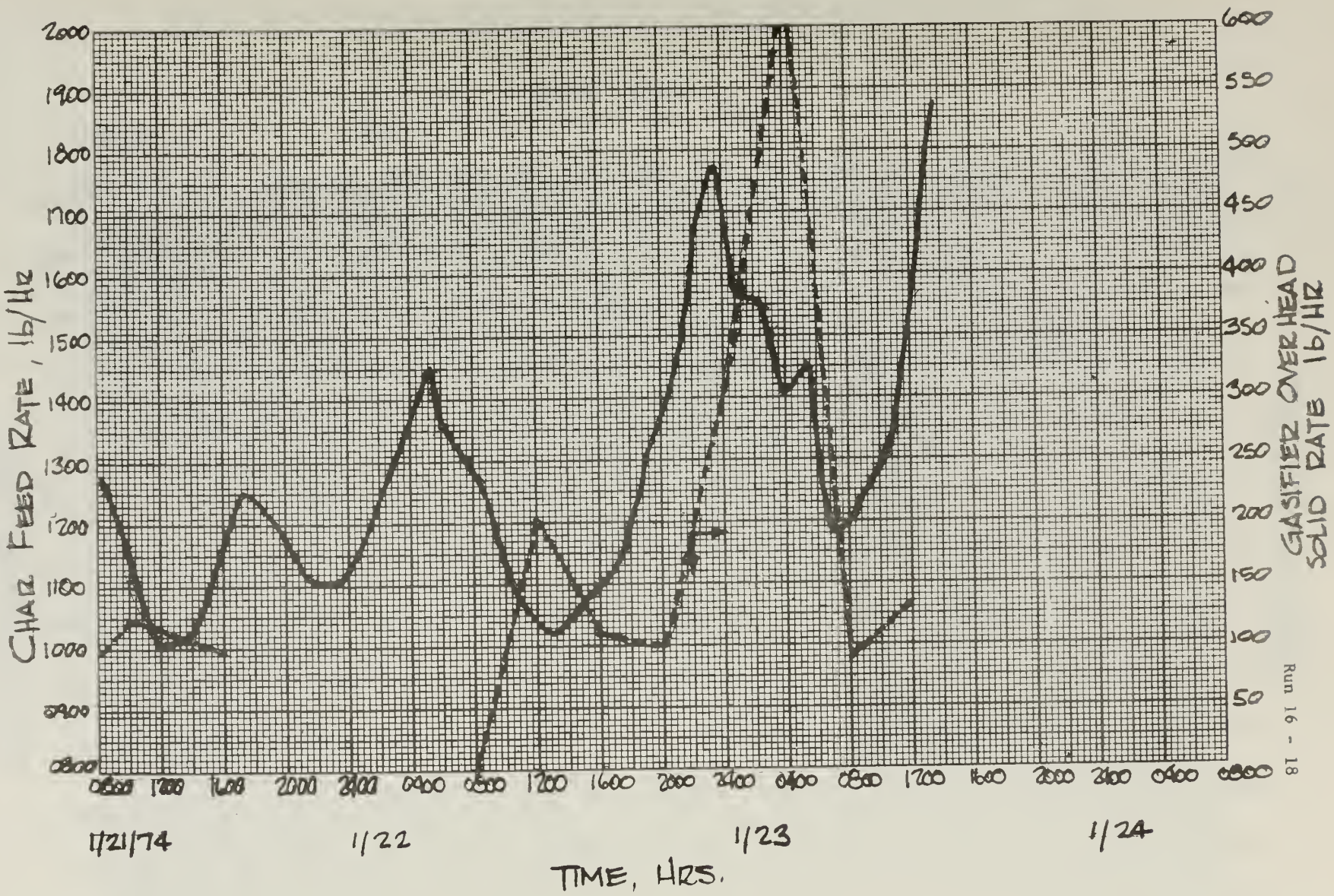

Figure 16-4. GASIFIER CHAR AND OVERHEAD SOLIDS RATES (PERIOD 1-18 to 1-21-74)

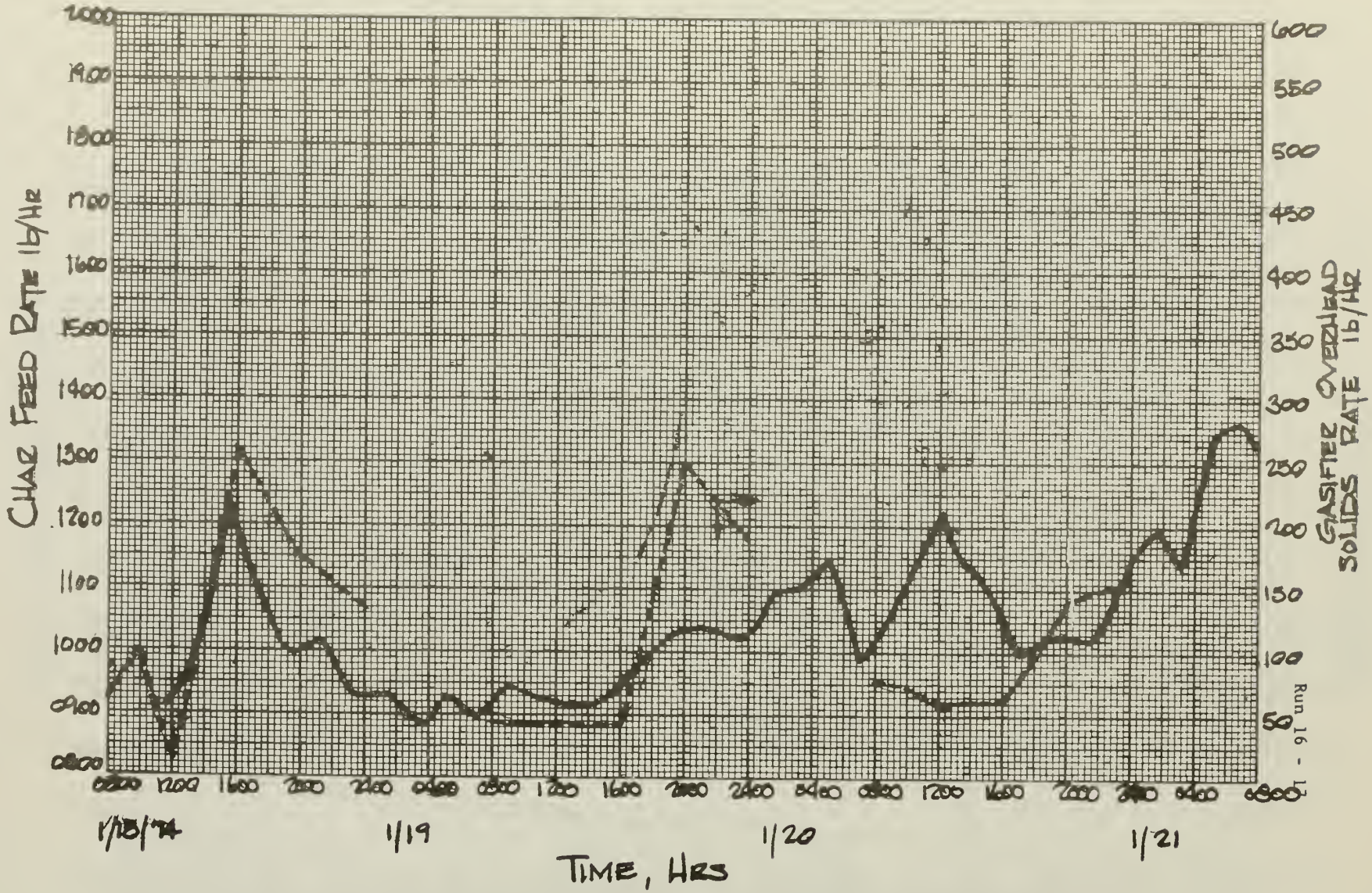

Figure 16-5. GASIFIER CHAR AND OVERHEAD SOLIDS RATES (PERIOD 1-21 to 1-24-74)

Date 1/16/74

Test	Gasifier Boot Temperature	Boot Gas Rate, SCFH	TCV-2030 Loading, PSI	Fill Time Min - Sec	dP Changes, IN W.C. dPR-2034	dPR-2035	dPR-2002	dPR-2001	dP Across TCV-2030 dPR-2026 IN, W.C.	dP Between TCV-2030 & Regenerator dPR-2025, IN, W.C.	Stone Weight, lbs	Flow Rate, lb/hr
1	1145	33,200	7	7-29.5	24.39	36.56	57.00	0	-10	114	560	4,485
2	1140	33,200	8	5-32.0	32.06	36.56	61.39	2.05	-10	106	631	6,842
3	1125	33,200	9	4-47.6	34.15	44.25	61.39	8.20	-10	108	720	9,013
4	1130	33,200	10	2-37.8	34.15	33.67	61.39	0	-10	147	623	14,213
5	1260	33,200	6	12-37.6	32.76	33.67	61.39	0	-10	123	611	2,903
6	1320	33,200	5	30-43.6	37.64	33.67	61.39	0	-10	124	655	1,279
7	1280	33,200	11	2-12.8	33.46	37.52	*	*	*	*	652	17,675
8	1240	33,200	12	1-51.2	30.67	44.25	*	*	*	*	689	22,312
9	1235	33,200	14	1-27.8	34.85	46.18	*	*	*	*	745	30,548

*Not recorded
Distance between taps, IN
dPR-2001 51
dPR-2002 36.5
dPR-2034 29
dPR-2035 40

Particle Density, lb/cu ft - 202
Bulk Density, lb/cu ft - 105

Table 16-1. DEAD BURNED DOLOMITE CIRCULATION TESTS

Run 16

Date	1/18	1/19	1/20	1/21	1/21	1/21	1/21	1/22	1/23	1/23	1/23	1/23
Time	1100	1100	1100	1100	1900	2100[1]	2300[1]	0900	0700	0900	1100	1300
Regenerator												
Jacket Steam Make, lb/hr	320	370	355	330	330	330	330	320	360	360	370	380
Dolomite Lift, SCFH	95,600	94,800	81,500	80,500	80,900	82,100	83,400	81,300	77,700	80,500	80,100	68,700
Char Lift, SCFH	7,630	7,420	7,400	7,340	7,150	7,150	7,150	7,270	7,400	7,400	7,400	7,520
Recycle - Air Line, SCFH	0	0	0	0	0	0	0	0	0	0	0	0
Air, SCFH	27,900	42,300	42,300	49,700	47,100	47,000	47,000	67,800	76,100	68,700	72,800	77,000
Total	131,130	144,520	131,200	137,540	135,150	136,250	137,550	156,370	161,200	156,600	160,300	153,220
Vent Rate, SCFH[2]	36,100[3]	51,400[3]	52,000[3]	59,000[4]	56,800[4]	58,000[4]	58,100[4]	76,300[4]	93,500[4]	83,300[4]	85,800[4]	92,800[4]
Average Bed Temperature, °F	1884	1855	1816	1885	1850	1850	1825	1857	1820	1850	1817	1892
Bed Velocity, ft/sec	2.89	2.71	2.42	2.61	2.53	2.55	2.55	2.93	2.98	2.93	2.96	2.92
Bed Density, lb/ft^3	102-122	84-105	86-114	75-96	75-95	75-95	75-95	80-104	87-110	78-105	95	90-108
Acceptor Makeup, lb/hr	0	300	450	450	450	450	450	450	450	450	600	450
Char Ash, lb/hr[5]	35	47	66	73	72	78	78	98	113	108	100	131
Ash + Attrited Acceptor, lb/hr[6]	49	65	80	89	111	120	120	130	145	138	250	328
Gasifier												
Jacket Steam Make, lb/hr	0	0	0	0	0	0	0	0	0	0	0	0
Boot, SCFH	26,800	27,800	27,000	28,200	24,100	22,700	23,800	25,200	13,500	16,600	20,300	13,600
Steam, SCFH	25,700	32,100	39,600	38,000	40,200	40,000	40,000	39,500	51,500	51,700	48,100	48,300
Air, SCFH	18,300	12,800	12,900	15,400	15,800	15,700	16,100	16,300	0	0	0	0
Total	70,800	72,700	79,500	81,600	80,100	78,400	79,900	81,000	64,500	68,300	68,400	61,900
Vent Rate, SCFH	37,100	32,100	33,900	34,500	38,000	35,600	37,400	36,600	17,600	16,600	18,700	20,300
Boot Temperature, °F	1451	1480	1507	1448	1430	1445	1440	1402	1439	1438	1450	1438
Bed Temperature, °F	1478	1500	1525	1488	1490	1490	1490	1483	1465	1475	1495	1495
Boot Velocity, ft/sec	1.38	1.46	1.43	1.45	1.23	1.17	1.22	1.27	0.69	0.85	1.05	0.70
Bed Velocity, ft/sec	0.75	0.78	0.86	0.87	0.85	0.84	0.85	0.86	0.68	0.72	0.73	0.66
Boot Density, lb/ft^3	68	66	63	58	55	56	56	59	(7)	(7)	(7)	(7)
Bed Density, lb/ft^3	40	40	39	39	38	39	39	40	46	47	50	46
Gross Btu, Btu/SCF[8]	161	187	192	174	186	194	182	177	289	310	332	296
Char Feed Rate, lb/hr	1,250	950	1,080	1,010	1,080	1,180	1,110	980	1,430	1,600	1,280	2,350
Overhead Solids, lb/hr[9]	14.5	80.3	61.8	123.5	95.0	-	-	202.9	89.6	89.6	133.9	-

(1) Balance period
(2) Calculated from nitrogen balance
(3) Includes CO_2 removed by HPC system
(4) HPC system out of service
(5) Based on oxygen balance
(6) Based on sodium balance
(7) Boot not fluidized
(8) Nitrogen included
(9) Samples reported closest to time taken

Table 16-2. REGENERATOR - GASIFIER DATA

Run 16

Date	Time	Regenerator Overhead	Regenerator Recycle	Mole Percent[1] O_2	CO	CO_2	N_2 + Ar	H_2	CH_4	H_2S	H_2O
1/18	1000		X	0	2.9	8.1	88.3	0.5	0.2	-	
	1100	X		0	3.3	10.3	85.9	0.5	0	-	
1/19	1000		X	0	2.6	2.5	94.3	0.6	0	-	
	1300	X		0	2.7	8.2	88.5	0.6	0	-	
1/20	0900	X		0	2.7	9.3	87.5	0.5	0	0.008	
1/21	1100	X[2]		0	1.1	21.1	77.5	0.3	0	-	
	1900	X[2]		0.05	2.4	21.0	76.6	0.2	0	-	
	2300[3]	X[2]		0	6.2	18.9	74.7	0.2	0	-	
1/22	1000		X[2]	0	0.8	20.6	78.6	Tr	0	Tr	
1/23	0700	X[2]		0.4	12.8	17.4	68.7	0.7	0	0.01	
	1100	X[2]		0	2.9	22.3	74.6	0.2	0	0	
		Gasifier Overhead									
1/18	1100			0	14.6	15.3	41.3	25.8	3.0	-	-
1/19	1100			0	15.0	12.5	31.1	31.9	3.5	0.02	
1/20	1100			0	13.9	14.7	34.2	33.5	3.7	0.11	
1/21	1500			0	13.6	15.2	37.1	30.6	3.4	0.04	15.9
	1900			0.1	13.0	14.8	35.1	33.5	3.4	0.01	41.2
	2300[3]			0	12.7	15.8	36.2	31.6	3.7	0.04	36.7
1/22	0700			0	13.5	15.1	35.5	32.0	3.9	0.10	29.1
1/23	0700			Tr	9.9	15.7	17.6	46.3	10.5	0.075	30.4
	0900[4]			Tr	14.2	15.9	9.0	48.0	12.4	0.5	-
	1100			0	12.2	12.1	7.6	57.8	10.3	0	14.6

(1) Calculated on a dry gas basis, H_2O is mole percent on the total gas volume
(2) HPC system out of service
(3) Balance period
(4) Recycle

Table 16-3. GAS ANALYSIS

Run 16

Date 1/14 - 1/23

	Dolomite		Char	
Screen Size Tyler Mesh	Dead Burned Wt %	6 X 9 Wt %	Screen Size Tyler Mesh	Wt %
+4	0	0.9	+6	
4 X 6	Tr	4.9	6 X 8	0
6 X 8	0.1	37.8	8 X 10	2.2
8 X 9	0.1	28.7	10 X 14	14.2
9 X 10	2.0	19.6	14 X 20	19.8
10 X 12	16.7	6.7	20 X 28	20.6
12 X 14	27.3	1.2	28 X 35	15.5
14 X 16	23.3	0.3	35 X 48	11.7
16 X 20	19.5		48 X 65	6.1
20 X 24	5.8		65 X 100	3.1
24 X 28	1.7		100 X 200	3.8
-28	3.5	0.1	-200	3.1
Particle Density, lb/cu ft	201.2			78.9
Calcining Weight Loss, %	0	36.2		
Ultimate Analysis, Wt %(1)				
Moisture				1.56
C				73.38
H				2.42
N				0.71
S				1.75
Ash				17.04
Elemental Analysis, Wt %(2)				
SiO_2	0.41(3)	5.12		21.64
CaO	59.16	55.03		27.19
MgO	37.67	35.83		11.10
Na_2O	0.07	0.07		1.47
Fe_2O_3	1.73	0.78		4.25
Al_2O_3	0.40	1.58		9.11
P_2O_5	0.01	0.01		0.04
TiO_2	0.15	0.05		0.44
K_2O	0.03	0.21		0.10
Total S	0	0.28		
SO_3				23.83
Sulfide		0.03		

(1) As received basis
(2) On calcined basis or total ash basis
(3) Dead burned analysis of November 20, 1973

Table 16-4. FEEDSTOCK COMPOSITES

Run 16

Date	1/18	1/21	1/21[1]	1/22	1/22	1/23
Time	1400	1000	2200	1000	2200	0200
Screen Size, Tyler Mesh	← Weight Percent →					
+8	0	0.1	0.3	0.2	0.2	0.2
8 X 10	0.1	1.5	1.5	1.8	3.4	2.4
10 X 14	15.3	17.6	12.8	19.6	17.6	15.7
14 X 20	25.2	22.7	15.8	22.1	17.0	17.5
20 X 28	17.4	19.7	19.4	19.5	18.0	19.0
28 X 35	12.5	16.1	21.9	18.3	19.4	19.3
35 X 48	13.1	12.8	16.9	12.0	14.7	14.2
48 X 65	9.4	5.9	7.3	4.5	6.0	6.7
65 X 100	4.6	2.5	2.9	1.5	2.5	2.9
100 X 200	2.1	0.5	0.9	0.5	1.3	1.8
-200	0.3	0.6	0.3	Tr	0.1	0.3
Particle Density, lb/cu ft		55.5		51.6	54.7	50.9
Ultimate Analysis, Wt %[2]						
Moisture	0.05	1.86	0	0	0	1.23
C	72.36	75.22	78.36	75.66	78.46	78.63
H	0.66	1.03	0.83	0.88	0.89	1.06
N		0.38				
S	0.75	0.96	1.60	1.16	0.89	1.14
Ash	19.26	18.85	20.28	19.80	19.16	18.29
Elemental Analysis, Wt %[3]						
SiO_2	23.36	26.97	18.40	21.05	24.37	19.64
CaO	36.99	36.05	35.46	36.88	36.19	37.50
MgO	11.60	7.69	12.07	12.57	11.62	12.25
Na_2O	1.99	2.12	2.60	0.60	1.81	1.81
Fe_2O_3	2.50	2.26	1.77	2.47	2.23	2.37
Al_2O_3	13.56	13.85	10.28	12.08	12.89	12.65
P_2O_5	0.04	0.04	0.04	0.02	0.04	0.04
TiO_2	0.37	0.45	0.49	0.66	0.59	0.62
K_2O	0.42	0.41	0.49	0.28	0.35	0.32

(1) Balance period data
(2) Analysis of 20 X 28 mesh on dried basis of an elutriated char sample
(3) Total ash basis

Table 16-5. GASIFIER CHAR TO REGENERATOR

Run 16

	Calcined Acceptor Return				
Date	1/21	1/21	1/21	1/21[1]	1/22[1]
Time	0000	0800	1700	2000	0000
Screen Size, Tyler Mesh	← Weight Percent →				
+4	0	0	Tr	0	0
4 X 6	0.4	0.5	0.7	0.5	0.4
6 X 8	2.8	2.9	2.6	3.0	2.2
8 X 9	5.2	4.8	4.8	5.2	4.2
9 X 10	13.8	15.7	17.0	18.3	17.4
10 X 12	25.2	23.7	22.8	23.6	23.9
12 X 14	27.0	27.3	26.4	25.4	26.6
14 X 16	15.8	14.8	12.4	11.5	12.0
16 X 20	6.3	5.3	5.6	5.2	5.4
20 X 24	1.6	1.9	2.5	2.4	2.4
24 X 28	0.8	1.3	2.0	1.8	1.9
-28	1.1	1.9	3.2	3.2	3.5
Elemental Analysis, Wt %[2]					
SiO_2		4.73			
CaO		54.45			
MgO		35.76			
Na_2O		0.09			
Fe_2O_3		1.49			
Al_2O_3		2.13			
P_2O_5		0.02			
TiO_2		0.15			
K_2O		0.02			
Total S	1.13	0.45	0.74	0.93	1.00
Sulfide	0.29	0.32	0.27	0.20	0.26

(1) Balance period data
(2) Calcined basis

Table 16-6. CIRCULATED ACCEPTOR, CALCINED ACCEPTOR RETURN (Sheet 1 of 2)

Run 16

	Calcined Acceptor Return				
Date	1/22	1/22	1/23	1/23	1/23
Time	0800	1600	0000	0400	0800
Screen Size Tyler Mesh	← Weight Percent →				
+4	0	0	0	Tr	0
4 X 6	0.2	0.3	Tr	Tr	0.1
6 X 8	2.0	1.5	1.1	1.0	1.1
8 X 9	4.2	3.7	4.1	4.3	5.0
9 X 10	18.8	17.4	19.4	20.7	20.2
10 X 12	24.0	21.7	23.5	21.8	20.6
12 X 14	25.2	23.5	22.6	21.6	19.0
14 X 16	10.6	10.4	8.6	9.0	7.6
16 X 20	5.4	6.1	5.5	6.5	6.1
20 X 24	3.0	3.2	3.1	3.9	3.9
24 X 28	2.5	3.0	3.2	3.7	4.5
-28	4.1	9.1	8.7	7.4	12.0
Elemental Analysis, Wt %(2)					
SiO_2	6.24				7.69
CaO	53.25				51.90
MgO	35.04				33.98
Na_2O	0.16				0.17
Fe_2O_3	1.53				1.73
Al_2O_3	2.47				3.46
P_2O_5	0.02				0.02
TiO_2	0.15				0.17
K_2O	0.03				0.04
Total S	0.12	0.97	1.07	0.97	0.32
Sulfide	0.04	0.13	0.14	0.12	0.12

(1) Balance period data
(2) Calcined basis

Table 16-6. CIRCULATED ACCEPTOR, CALCINED ACCEPTOR RETURN (Sheet 2 of 2)

Run 16

	Recarbonated Acceptor Return									
Date	1/19	1/20	1/21	1/21	1/21[1]	1/22	1/22	1/22	1/23	1/23
Time	1000	1000	0415	1000	2200	0600	1400	2200	0200	1600
Screen Size, Tyler Mesh	← Weight Percent →									
+4	0	0	0.1	0.2	0	0	0.1	0	0.2	0
4 X 6	0.2	0 3	0.5	0.7	0.3	0.4	0.4	0.1	0.1	0
6 X 8	0.9	2.1	4.0	3.4	2.9	3.3	2.9	1.2	1.2	0.8
8 X 9	1.2	3.1	6.2	6.0	5.7	6.4	6.6	3.5	3.5	2.8
9 X 10	4.1	8.5	15.4	15.6	18.5	20.6	22.7	16.1	15.3	10.3
10 X 12	15.8	20.1	22.2	21.9	24.1	24.6	26.0	19.4	17.9	13.6
12 X 14	28.2	27.7	25.2	25.9	25.7	25.0	25.0	20.9	17.3	15.1
14 X 16	22.9	20.3	15.3	14.8	12.4	10.9	9.0	8.9	8.0	8.6
16 X 20	16.3	11.4	6.5	6.3	5.5	5.1	4.5	6.5	6.6	8.8
20 X 24	4.8	3.0	2.1	2.5	2.3	2.2	1.7	4.2	4.5	6.4
24 X 28	2.1	1.9	1.7	2.0	1.6	1.1	0.8	4.8	5.9	9.3
-28	3.4	1.5	0.8	0.8	1.1	0.4	0.3	14.3	19.5	24.4
Particle Density, lb/cu ft		174.2							153.3	152.6
Activity[2]										
Total	0.05	0.11	0.10	0.13	0.17	0.18	0.17	0.15	0.18	0.23
Screen										
6 X 8				0.13			0.19			0.53
10 X 12				0.12			0.13			0.15
12 X 14				0.10			0.15			0.18
Elemental Analysis, Wt %[3]										
SiO_2				5.02			5.01			9.03
CaO				53.84			54.37			50.44
MgO				34.94			35.74			32.58
Na_2O				0.08			0.10			0.20
Fe_2O_3				1.52			1.53			2.11
Al_2O_3				2.15			2.37			3.89
P_2O_5				0.02			0.02			0.01
TiO_2				0.14			0.12			0.18
K_2O				0.02			0.02			0.03
Total S			0.94	0.54	0.63		0.30	0.86	1.04	0.49
Sulfide			0.37	0.18	0.53		0.13		0.34	0.25

(1) Balance period data
(2) Activity of total sample and of various screen fractions
(3) Calcined basis

Table 16-7. CIRCULATED ACCEPTOR, RECARBONATED ACCEPTOR RETURN

Run 16

Date	1/21	1/21[1]	1/22	1/23	1/23
Time	0800	2135	1200	0800	1200
Screen Size Tyler Mesh	← Weight Percent →				
+60		0.8	7.9		0.6
60 X 100		20.4	9.5		2.3
100 X 325		50.3	73.5		33.2
-325		28.6	9.1		63.8
Wt % Solids to Organic Pond	0.59	1.39	0.85	0.38	0.56
Ultimate Analysis, wt %[2]					
Moisture	0	0	0	0	0
C	59.77	58.24	69.39	61.63	53.61
H	1.06	0.91	1.00	1.24	1.05
N	0.3		0.30	0.37	
S	1.61	1.92	1.98	1.87	0.94
Ash	32.73	35.46	20.80	33.51	38.42
Elemental Analysis, Wt %[3]					
SiO_2	29.80	30.25	26.86	36.08	25.93
CaO	31.95	32.50	31.54	24.58	34.85
MgO	4.26	4.69	3.98	4.12	6.06
Na_2O	1.75	1.53	0.42	0.91	0.97
Fe_2O_3	7.90	10.41	16.98	10.70	17.84
Al_2O_3	12.85	11.87	10.58	9.94	7.92
P_2O_5	0.24	0.02	0.01	0.04	0.04
TiO_2	0.77	0.41	0.50	0.60	0.68
K_2O	0.18	0.26	0.17	0.16	0.26
SO_3	11.36	8.38	9.60	14.35	4.62

(1) Balance period data
(2) On a dried basis
(3) Total ash basis

Table 16-8. GASIFIER CHAR TO ORGANIC POND

Run 16

Date	1/19	1/21	1/21[1]	1/22	1/23	1/23
Time	0010	0915	2350	1000	0935	1200
Screen Size Tyler Mesh	← Weight Percent →					
+35	1.6	2.8	2.4	4.1	9.2	25.1
35 X 48	3.7	5.5	3.9	5.1	7.2	13.1
48 X 65	9.3	9.9	5.8	7.1	7.9	6.9
65 X 100	15.4	12.9	9.2	10.9	10.4	5.5
100 X 200	24.3	18.5	18.3	23.4	17.7	11.4
200 X 325	14.1	19.0	18.2	18.2	12.6	11.4
-325	31.7	31.3	42.0	31.2	34.9	26.7
Ultimate Analysis, Wt %[2]						
CO_2	1.6	Tr	0.9		1.8	Tr
C	3.5	Tr	3.6		Tr	Tr
Ash	94.9	99.9	95.5		98.2	99.9
Elemental Analysis, Wt %[3]						
SiO_2	18.63	16.67	15.35	17.14	16.16	14.39
CaO	41.77	44.34	44.41	44.43	44.59	44.71
MgO	24.13	22.45	23.44	24.40	25.03	27.50
Na_2O	1.35	1.48	1.20	1.44	1.35	0.78
Fe_2O_3	2.61	1.46	1.24	1.49	1.89	1.92
Al_2O_3	7.46	7.40	6.20	7.04	7.05	6.25
P_2O_5	0.03	0.02	0.03	0.02	0.02	0.03
TiO_2	0.37	0.24	0.22	0.24	0.25	0.25
K_2O	0.40	0.67	0.57	0.69	0.59	0.40
Total S	1.60	2.96	2.61	1.46	4.77	1.34
Sulfide	0.68	2.24	1.84	1.36	1.28	0.76

(1) Balance period data
(2) As received basis
(3) Total ash basis

Table 16-9. ASH AND ATTRITED ACCEPTOR

Run 16

Date 1/23

	Regenerator Dump				Gasifier Dump				
Screen Size Tyler Mesh	Top	Middle	Bottom	Screen Size Tyler Mesh	Top				Bottom
	Weight Percent				Weight Percent				
+4	0	0	0	+6	0	-	-	-	-
4 X 6	0	0	0	6 X 8	0	0.2	0.2	0.1	0.8
6 X 8	1.0	0.8	0.6	8 X 10	1.3	4.1	4.5	2.8	12.9
8 X 9	3.0	5.5	5.9	10 X 14	10.7	11.3	11.7	14.0	35.5
9 X 10	9.0	18.7	15.8	14 X 20	14.9	9.6	9.4	18.0	14.7
10 X 12	10.1	20.8	18.3	20 X 28	18.7	14.8	13.9	22.7	12.0
12 X 14	10.0	17.9	16.8	28 X 35	18.0	19.7	15.7	14.4	10.7
14 X 16	6.3	8.5	8.0	35 X 48	15.7	18.3	15.2	4.6	7.1
16 X 20	6.4	7.4	7.2	48 X 65	10.7	11.4	12.2	13.0	3.7
20 X 24	5.4	4.8	7.3	65 X 100	6.2	6.7	7.0	6.8	1.7
24 X 28	9.3	6.0	6.8	100 X 200	3.7	3.8	3.9	3.5	1.0
-28	39.5	9.7	13.3	-200	Tr	0.1	0.1	Tr	Tr
Particle Density, lb/cu ft	155.3	161.6	176.2				50.5		
Activity	0.1	0.1	0.1						
Calcining Weight Loss, %	3.5	2.0	4.2						
Ultimate Analysis, Wt %(1)									
Moisture					0.14	0.21	0.21	0.27	0.20
C					76.17	77.21	77.02	77.79	77.43
H					0.91	0.93	1.03	0.95	1.00
N					0.26			0.28	
S					0.13	0.18	0.16	0.13	0.29
Ash					17.14	16.99	16.10	17.24	16.88
Elemental Analysis, Wt %(2)									
SiO_2	9.62	8.14	7.38		23.43	24.42	23.44	22.61	25.33
CaO	50.76	51.26	52.24		43.08	41.83	41.86	42.77	38.41
MgO	31.15	33.13	33.15		13.33	13.01	13.02	13.19	12.10
Na_2O	0.23	0.14	0.14		1.44	1.54	2.05	1.85	1.78
Fe_2O_3	2.97	2.63	2.92		3.08	2.49	2.50	2.60	2.50
Al_2O_3	4.35	3.70	3.45		0.21	0.24	0.30	0.31	0.36
P_2O_5	0.01	0.01	0.01		14.17	13.71	13.72	13.73	14.97
TiO_2	0.16	0.12	0.23		0.04	0.04	0.03	0.04	0.03
K_2O	0.18	0.07	0.08		0.49	0.32	0.44	0.62	0.30
Total S	0.34	0.28	0.26						
SO_3					1.46	1.79	1.67	1.65	3.56
Sulfide	0.09	0.06	0.08						

(1) Analysis on an elutriated char sample of 20 X 28 mesh, as received basis
(2) Calcined basis or total ash basis

Table 16-10. SOLIDS REMOVED AT SHUTDOWN

RUN 17

FEBRUARY 22 TO APRIL 18, 1974

CO_2 ACCEPTOR PROCESS GASIFICATION

PILOT PLANT

RAPID CITY, SOUTH DAKOTA

1 SUMMARY

Run 17 was divided into three parts: Runs 17A (February 22 to March 2, 1974); 17B (March 19 to April 2, 1974); and 17C (April 16 to April 18, 1974). The objective for these runs was to achieve long-term, integrated plant operation via a stepwise procedure. The program involved establishing base conditions at which the acceptor circulation and percent carbon burnoff were held constant at 11,000 LB/HR and 56 percent respectively. From this starting point, adjustments were made to bring the plant to a set of target conditions at which the gasification heat requirements were provided by the circulating acceptor.

Since dead-burned dolomite was used as a startup material, the initial acceptor activity was near zero and most of the gasification heat requirements were supplied by injecting air into the gasifier char bed. Once the base conditions were met, fresh acceptor makeup at 600 LB/HR rate and spent acceptor withdrawal were initiated. This was done to gradually increase the acceptor activity and thereby eliminate the need to supply heat to the gasifier by air addition.

During Run 17A, the plant was operated for 56 hours in an integrated manner, and the base conditions were established. However, before fresh acceptor makeup was initiated, the convection section coil of the gasifier recycle heater, B-201-IIIA, ruptured. Significantly, Run 17A was the second consecutive startup accomplished without plugging problems in the calcined acceptor return line. Smooth plant operation also provided valuable data on gasifier performance.

The dead-burned dump material from Run 17A was used as a startup feedstock for Run 17B. This run proceeded smoothly and featured 158 hours of integrated plant operation, 72 hours with fresh acceptor makeup, and 16 hours with no air addition to the gasifier. For the first time, the gasifier temperature was maintained at 1500^{o} to 1520^{o}F without the aid of air.

Seventy-two hours after fresh acceptor makeup was initiated, the stone's activity had apparently lined out at 0.16. The periodic regenerator temperature excursions which were experienced throughout the run may have been responsible for the low activity. However, due to the premature shutdown of Run 17B, a study of acceptor response to various plant conditions could not be made.

Termination of Run 17B occurred as a result of attempts made to remove a plug from the recarbonated acceptor standleg sample station. When the plug broke, the contents of the standleg, both solids and gas, came out the vent valve and ignited. Since the valve could not be closed, the plant was shut down.

Run 17C was attempted using stone removed from the gasifier during Run 17B. The run was aborted prior to char addition when it became impossible to maintain reliable acceptor circulation through the calcined acceptor standleg. Since inspection of the line and valve revealed no obstructions, the used stone was suspected of causing the unreliable circulation.

Three tests were carried out during Runs 17A and 17B startups. The first was to check the consistency between the regenerator and gasifier vent orifices with the air flow orifices. In the second, the gasifier steam orifices were calibrated. Correlations between the acceptor circulation rate and the flow control valve position or the lift line pressure drop were obtained in the third test.

Most importantly, the Run 17 series contributed valuable information on acceptor circulation rate, gasifier char bed performance in the presence of showering acceptor, and pressure balance data.

The objectives for Run 18 are identical to those for Run 17. In addition, attempts will be made to study conditions affecting acceptor activity.

2 TEST DATA

Run 17 data are presented graphically and/or tabularly at the end of this run report. These figures and tables include:

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3 SIGNIFICANT EVENTS AND OBSERVATIONS

3.1 HISTORY OF RUNS 17A, 17B, AND 17C

3.1.1 Purpose

The goal for the Run 17 test series was to sustain long-term, integrated plant operation, ultimately culminating with the complete removal of air to the gasifier.

3.1.2 Accomplishments

Runs 17A and 17B

(1) Successfully measured acceptor circulation rate and correlated circulation data as a function of lift line pressure drop.

(2) Eliminated plugging and scale formation problems in the calcined acceptor return line.

(3) Obtained gasifier performance data for acceptor circulation rates over the range of 4,000 to 11,000 LB/HR.

(4) Achieved operating temperature of 1840^{o}F in the regenerator by char combustion.

(5) Maintained gasifier operating temperature of 1520^{o}F via air addition and acceptor circulation.

(6) Operated plant in an integrated manner with continuous acceptor circulation while maintaining operating temperatures in both reactors. Total hours of integrated operation were 56 and 158 for Runs 17A and 17B respectively.

(7) Controlled the gasifier char bed density without excessive stone retention even at the high acceptor circulation rate of 11,000 LB/HR.

Run 17B

(1) Successfully fed fresh acceptor and purged spent acceptor to maintain stable inventory for 72 hours.

(2) Operated gasifier for 16 hours without the aid of air injection while maintaining reactor temperature at 1520^{o}F.

Run 17C

(1) Pressurized and heated system.

(2) Established acceptor inventory in regenerator.

3.1.3 Termination Causes

Run 17A

Two tubes in the gasifier recycle gas heater convection section (B-201-IIIA) ruptured forcing the plant to be shut down.

Run 17B

The plant was shut down shortly after the recarbonated acceptor sample station was vented to remove a plug. When the plug broke, the vent valve could not be closed, the system began to depressure, and a fire resulted at the sample station.

Run 17C

The plant was shut down before char was added to the gasifier when it became apparent that reliable acceptor circulation could not be maintained through the calcined acceptor standleg.

3.1.4 Mechanical Problems

Run 17A

(1) During a startup attempt, the calcined acceptor control valve, TCV-2030, seized.

(2) The sheath containing the gasifier pressure probes failed due to embrittlement caused by temperature cycling at the point at which the probe penetrated past the refractory lining.

(3) The new chromium carbide coated acceptor lift line cones showed significant wear after the run.

(4) Plugging of the gasifier quench tower water outlet by char fines caused system pressure upsets.

Run 17B

(1) The spent acceptor transfer line to the dump hopper, F-213, plugged several times due to steam condensation.

(2) The heater stack damper, which controls the flow of flue gases past the B-201 heater convection coil, was found to be in poor condition.

(3) The new acceptor lift line slip joint cones, which were coated with nickel aluminide, showed significant wear after the run.

(4) Hot spots developed on several double walled solids transfer lines due to either end plate failures or slippage of the annular refractory insulation.

Run 17C

No major mechanical problems were experienced.

3.1.5 Process Problems

(1) Corrosive attack of the gasifier recycle gas heater coils continued to occur during Run 17A. Chromium carbide formation appears to be responsible for the metal losses.

(2) The acceptor activity leveled off at a lower value than expected during Run 17B.

3.2 CHRONOLOGY OF OPERATIONS

3.2.1 Run 17A

Date	Time	Hours Counting	Description
2/22	0930		Started pressuring system
"	1100		System at 150 PSIG Started vent flow calibration tests
"	2020		Tests finished. Air removed from System
2/23	0100		Gasifier and regenerator overhead gas analyzers calibrated and put on line
"	0800		Started flow comparison tests between new steam orifices and gasifier air flow orifice
2/24	0030		Tests completed
"	0215		Zinc oxide system on line
"	0250		Started dead-burned dolomite to gasifier boot via lignite lockhopper F-204A
"	0425		Transfer of acceptor from gasifier to regenerator through a manually operated level control valve, LCV-2003
"	0505		Feeding acceptor to regenerator from makeup lockhopper
"	0515		First lockhopper of dead-burned dolomite (F-204A) emptied

Date	Time	Hours Counting	Description
2/24	1300		Acceptor filling from F-204 A/B complete, both empty. Continue to fill regenerator from F-206
"	1825-1850		Dolomite circulation tested
"	1850		Preparations made for steam-gas ratio tests; i.e., steam and air to unit
2/25	0000		Dolomite circulation initiated. (5 PSI loading to TCV-2030)
"	0335		Steam-gas ratio tests discontinued. Acceptor circulation tests begun
"	0845		Circulation tests completed
"	0945		Started lift line gas flow tests
"	1000		Finished lift line tests and resumed solids (acceptor) circulation
"	1100		Started steam flow tests
"	1325		Tests complete. Circulation stopped
"	1507		Started adding char to gasifier
"	1710		6 X 9 acceptor screening begun
"	1804		Started air to gasifier (5,000 SCFH to side)
"	2050-2135		Added acceptor to regenerator to maintain level
"	2345		Gasifier char bed level at 25 feet
"	2400		Char feed put on level control Raising gasifier temperature to increase gasification rate and lower density of gasifier char bed
2/26	0520		Checked integrity of fuel char transfer to regenerator
"	0527		Char transfer shut off
"	1840-1845		Evacuation alarms tested. NOTE: During the past two shifts, char was ground and charged to the preheater. The oversize line from the scalping screen plugged several times, but the preheater was filled.
2/27			NOTE: The char bed density dropped to 29.5 LB/CU FT by 2400 hours 2/26/74
"	0700		Char bed density, as indicated by dPR-2031, lined out at 29 LB/CU FT. Started cooling B-203 and B-204 heaters in preparation for methane combustion in regenerator
"	0750		Transferred char from gasifier to regenerator long enough to get sample (10 minutes)
"	0830		Heaters B-203 and B-204 at 800°F. Methane used to heat regenerator
"	1145		Started acceptor circulation

Date	Time	Hours Counting	Description
2/27	1250		Air started to regenerator
"	1340		Char started to regenerator
"	1445		Char feed interruption
"	1500-1800		Line between gasifier and acceptor dump hopper plugged
"	1800		Stopped fuel char transfer and acceptor circulation in order to blow line between gasifier and F-213
"	2048		Preparing to start acceptor circulation
"	2110		Line between F-213 and gasifier cleared
"	2140		Dumped 650 LBS of solids from F-213
"	2146		Char transferred from gasifier to regenerator. Air started to regenerator
"	2215		F-213 back in service
"	2255		Beginning of a series of problems leading to loss of interface 1. J-314 B (quench water pump) kicked off; when restarted, the quench tower flooded 2. The gasifier recycle gas knockout pots (F-308 and F-314) filled, preventing flow of gas 3. Water carried over into the gasifier vent line 4. Gasifier pressure increased to 168 PSI before the bypass around the vent pressure control valve could be opened 5. Interface was lost. Regenerator fuel char feed was stopped NOTE: Effort next 2 hours directed at clearing lines of water, lining out of quench system and reestablishing interface
2/28	0115		Gasifier boot flow lowered and then gradually increased in effort to reestablish interface
"	0130		Dumped some of the gasifier boot contents to F-213 to help establish interface. Seems to help interface formation. Interface established
"	0150		Starting acceptor makeup to regenerator and constant withdrawal from gasifier boot to F-213 NOTE: Continue to carry water from gasifier quench system into knockout pot, F-306, but level control valve handled load
"	0155		Intermittent transfer of acceptor from gasifier to regenerator started

Date	Time	Hours Counting	Description
2/28	0215		Char feed to gasifier started. Lowering B-203 heater outlet temperature to 800°F
"	0320		Started acceptor circulation at a 5 PSI loading on TCV-2030. Bottom of gasifier quench tower appeared to be plugged between the separator
"	0400		Started char transfer from gasifier to regenerator
"	0910		Worked on gasifier quench tower to remove the plug. Overfilled the separator and shook it up. Plug removed. Increasing char and air to increase the regenerator temperature. Also raised the loading on TCV-2030 valve to increase acceptor circulation
"	1200	0	Regenerator at 1800°F
"	1257		Regenerator recycle compressor J-207 B shut down. Not needed
"	1310		Compressor J-207 A shut down. Not needed
3/1	0530		Two small hot spots found on calcined acceptor standleg CD-206. Both less than 600°F
"	0945	21.8	"A" gas purges on calcined acceptor transfer line replaced with nitrogen purges in preparation for the addition of fresh 6 X 9 mesh acceptor
"	2230	34.5	Problem with gasifier quench system plugs. Flooded separator and cleared obstruction
3/2	0215-0615		Experienced excessive water carryover from the gasifier quench system. Solids accumulation in the quench tower bottom apparent cause of problems
"	1355	49.9	Recharged spend ZnO tower and put back in service
"	1700		Increased acceptor circulation
"	2045	58.8	Tube in B-201-IIIA heater failed. System depressured by activating ESD-2 system. System inerted
"	2330		Dumping gasifier to F-213
3/3	0300		Gasifier emptied. Cooling unit down for emptying regenerator

3.2.2 Run 17B

Date	Time	Hours Counting	Description
3/19	1140		Plant turned over to Operations. Starting to pressure test unit
"	1340		Leak from TCV-2030 packing. Depressuring to repair
"	1600		Starting pressure test again
"	2000		Started gas flow consistency tests between regenerator air orifice place and new steam orifice plates
"	2200		Finished flow test
3/20	0315		Took air out of system. Inert gas put in and all recycle compressors put on. Gas circulation established. Heaters checked out
"	1645		Vent calibration flow test begun NOTE: Instrument problems with regenerator air transmitter, FRC-2113. Ran flow tests at varied conditions during day shift
"	1430		Started static pressure leak test
"	1810		Static test completed
"	1840		Started compressors
"	1850		Heaters lit
"	1945		Heaters at 250^{o}F and holding to cure refractory
"	2200		Heat up continuing after refractory cured out
3/22			NOTE: Gasifier heater stack dumper, PICV-2044, not working, causing poor temperature control
"	1400		Put steam in side of gasifier. Recycle taken out
"	1420-1445		Put 20,000 SCFH air into side of gasifier and replace recycle gas in regenerator air line with air in preparation for steam flow tests NOTE: Damper TCV-2059 on B-201-B heater stuck, shaft broken
"	2200		First step of steam tests (4 roots on FRC-2302) complete. Continuing (6 roots on FRC-2302)
3/23	0130		Second step of steam flow tests completed
"	0405		Gasifier side flow steam tests complete. Preparing for boot flow steam tests
"	0636		First step of boot steam flow tests completed
"	1330		Boot steam flow tests complete. Started cooling heaters in preparation for maintenance work
"	1345		All steam and air out of gasifier and regenerator

Date	Time	Hours Counting	Description
3/23	1510		Heaters down. Shutting down circulation and depressuring
"	1655		Began pressuring system again
"	1845		Gas circulation started in regenerator system. Regenerator heaters lit (B-203, B-204, and B-205)
"	1905		Gas circulation started in gasifier system. Gasifier heaters lit (B-201). Damper repair complete. NOTE: Maintenance work done: 1. Cyclone feeder freed up 2. Jim Dandy repacked 3. Damper TRC-2059 repaired. Old one (pieces) removed, new one fabricated 4. Fuel char sample point (S-13) cleared
3/24	0030		Zinc oxide system put onstream
"	0100		All heaters at prescribed temperature
"	0205		Started feeding dead-burned dolomite to gasifier from F-204 B lignite lockhopper
"	0300		First transfer of dolomite from gasifier to regenerator. Transfer as temperature permits
"	0315		Started dolomite feed from F-206 (feeder L-204 at 300 LB/HR)
"	0330		Feed from F-204 discontinued for now. Increasing dolomite feed rate from F-206 to about 1,500 LB/HR
"	1000		Checked ability to dump spent acceptor to F-213
"	1230		Started acceptor circulation
"	1515		Some trouble experienced in dumping acceptor to F-213. Gasifier boot level control valve, LCV-2003, stuck open. Operator had to manually close. Circulation shook up and reestablished
"	1940		Started circulation tests. Seven PSI loading is minimum on test due to seemingly low circulation rate
3/25	0330		Found hot spot on calcined acceptor stand-leg line CD-206 (top side of pipe 3 feet off floor). Temperature between 350° and 500°F
"	0435		Acceptor circulation rate tests finished
"	0445-0530		Working on "A" ash lockhopper inlet plug using pressure differential between system and lockhopper. Decision made to perform a final circulation test until some decision is made concerning the plugged "A" lockhopper inlet

Date	Time	Hours Counting	Description
3/25	0600		Check ability to dump acceptor to F-213
"	0740		Tests on lift line flow at constant circulation rate and with various lift gas rates completed
"	0745		Pressured "A" ash lockhopper to 240 PSI and blew plug out of inlet
"	0800		Restarted circulation. Made dump check to F-213. OK
"	0845		All sample stations checked. Open and OK
"	1200		Steam put to gasifier side
"	1215		Circulation stopped
"	1220		Char feed to gasifier initiated
"	1300		Interface established
"	1425		Small amount of air added to gasifier to heat char bed
			NOTE: Problems with plug in outlet of ash lockhoppers. Maintenance called out to disassemble and clear
"	2315		Char bed of 25 feed attained
"	2318		Char transferred to regenerator for 7 minutes. Fuel char sample taken
3/26	0125		Char grinding started to top off preheater
			NOTE: Sample schedule instituted
"	0420		Attempted to dump acceptor to F-213 with no immediate success
"	0530		Char grinding complete
"	0710		Used high pressure inert gas to break plug above F-213. Closed ball valve above F-213 and vented gas into gasifier. Shook up boot slightly
"	0730		Unit levels back in good shape and line to F-213 open
"	0850		Regenerator heater B-203 and B-204 cooled
"	0930		F-213 dumped
"	1110		Started acceptor circulation, makeup set at 1/2 RPM
"	1125		Started char transfer to regenerator from gasifier. Set up continuous acceptor withdrawal to F-213
"	1255		Steam introduced to gasifier boot (5,000 SCVH)
"	1325		Started reducing recycle gas to regenerator air line
"	1445		Regenerator in 1800^{o} to 1840^{o}F range
"	1500	0	Start of hour count
"	2005		Shut down regenerator recycle gas compressor J-207 A/B because they were no longer needed

Date	Time	Hours Counting	Description
3/26	2345		Started char grinding to fill preheater
3/27	0035		Acceptor circulation started to decrease
"	0220		Lost char transfer from gasifier to regenerator. Problems getting seal on LCV-2002. Natural gas used to maintain regenerator temperature
"	0238		Lost some of the acceptor circulation through TCV-2030
"	0315		Blew into char sample point, S-13, on first floor (had been plugged). It is now open, used 350 PSI inert. Seal recovered on LCV-2002. Natural gas removed from regenerator
"	0410		Emptying F-213
"	0500		Completed char grinding to fill preheater
"	0535		F-213 back in service
"	0850		J-207 A/B compressors put back into service so that J-203 A compressor can be worked on
"	1130		Starting increase of valve loading on TCV-2030 (0.25 PSI per half hour) until dPR-2022 reads 35 lines (8,000 LB/HR)
"	1230-1300		Lost char feed twice, regained by pulling sample on first floor NOTE: By 1430 hours, the char feed problems were overcome
3/27			NOTE: Increased steam to gasifier side gradually until dPT-2044 reached 40 lines (gasifier cyclone differential). This was done to get better showering
"	2230	31.5	Started increasing acceptor circulation through TCV-2030 in small increments of valve loading until dPT-2022 reaches 45 lines (11,000 LB/HR)-(0.25 PSI per half hour)
"	2345		Hot spot noted on acceptor lift line CD-208 just under XCV-2010. Temperature between 400° and 600°F
3/28	0015		Problems: Working on boot steam flow transmitter, FRC-2021, and by mistake, the transmitter on FRC-2020 was blocked in. This made the boot recycle gas control valve, FCV-2020, open fully which in turn destroyed the interface. Circulation was stopped but char transfer was not cut off completely. Regenerator temperature reached 1909°F. Although the CO concentration was low, no oxygen breakthrough was experienced

Page	Time	Hours Counting	Description
3/28	0030		Regaining interface boot flow was decreased to less than 10,000 SCFH
"	0050		Acceptor circulation started again. Had trouble maintaining acceptor transfer from regenerator to gasifier. Blew in at S-9 sample point to improve circulation
"	0200		Conditions seem lined out and steady-state
"	0240		Char grinding to fill preheater
"	0300	36	Obtained balance period for 11,000 LB/HR acceptor circulation rate
"	0430		Board instruments indicate a slowdown of acceptor transfer. TCV-2030 was stroked
"	0500		Acceptor circulation seems OK NOTE: A recurring hot spot on seventh floor appeared again
"	1215		Pressure shake up, possibly due to false indication on ash lockhopper pressure which allowed the hopper to be put back on line too soon
"	1545		F-206 charged with 4,750 LBS of fresh 6 X 9 dolomite
"	1600		Required 2 hours to dump F-213 due to plug-gages and wet material
"	1630		Increased steam flow to gasifier side
"	1850		Char transfer from gasifier to regenerator lost. Efforts to unplug unsuccessful. Steam from gasifier getting into the acceptor dump hopper
"	2100		Removed 4,000 SCFH steam from gasifier side
"	2320		Removed all steam from boot of gasifier
"	2350		Char transfer became erratic
3/29			NOTE: Hot spots: CD-206 (7th floor), 300^{o}F; CD-208 (6th floor), 375^{o}F
"	0200		Line between gasifier and F-213 plugged. Rod out plugged, can't hammer rod through or pressure with K-bottle. 300 PSIG on F-213 will not relieve into gasifier. F-213 was de-pressured but no flow was obtained from gasi-fier into hopper
"	0345		Continuous char transfer established NOTE: Discontinuous char feed was experienced from 2350 to 0345 hours
"	0525		Char grinding to fill preheater
"	0630		Increased steam to side of gasifier NOTE: Next two shifts spent attempting to clear line to F-213

Date	Time	Hours Counting	Description
3/29	1745		Interface lost. Inert gas blown into rod out point to gasifier. Regained interface by lowering boot flow
3/30	0030	81.5	Line to F-213 opened. Began transfer from gasifier to F-213
"	0035		Started fresh 6 X 9 dolomite feed to regenerator NOTE: The makeup dolomite feed rates are being adjusted to hold regenerator levels and to maintain continuous acceptor withdrawal to F-213
"	0330		Spent acceptor leaking through XHC-2073. Ball valve aboev F-213 used to throttle solids flow. S-10 sample point plugged
"	0910		J-207 B taken off line
"	1000		S-10 sample point cleared
"	1050		F-206 low level, recharging and dumping F-213
"	1125		F-206 and F-213 back in service NOTE: Gradually decreasing reactor differential and raising acceptor circulation during this period. Hot spot on CD-208 on fourth floor, 650°F
3/31	0730		Removed half the recycle flow from the regenerator air ring
"	1900		Increasing char feed rate
"	2220		Venturi on regenerator quench now wide open NOTE: Continue to reduce air flow to gasifier was increased temporarily while F-206 was filled. Had to raise air slightly to hold gasifier temperature
4/1	0830		Recycle to regenerator air heater completely removed
"	0837		Shut down J-207 A compressor
"	1200	141	Air to gasifier removed
4/2	0345	156.75	Plug blow out of S-10 sample point during attempts to clear the station. This caused a fire on the first floor. Plant was shut down using the ESD-2 system
"	0430		Plant secure, fire out and cooling. Mop-up operations underway

4 RESULTS AND DISCUSSION

4.1 BACKGROUND

Run 16 was the first run in which dead-burned dolomite was used for the initial regenerator inventory. This startup procedure modification greatly improved operations by eliminating the massive amounts of fines generated during the calcination of an entire bed of fresh acceptor. Control of acceptor circulation through the calcined acceptor standleg was also improved. Unfortunately, due to slip joint failures in the acceptor lift line, Run 16 ended before variable studies on acceptor activity and showering performance could be made.

The Run 17 startup also incorporated the use of dead-burned dolomite. However, the approach to the problem of removing air as a heat source to the gasifier was different than that used for Run 16. Throughout most of Run 16, the acceptor circulation was relatively low, about 7,000 LB/HR. Towards the end of the run, the circulation rate was increased to about 15,000 LB/HR in order to allow removal of the gasifier air. This manner of operation did not allow adequate control of the showering acceptor inventory. Ultimately, the gasifier boot gas rate had to be lowered to stripping efficiency and potentially could have allowed agglomeration of the boot acceptor since the gas velocity was below that required for incipient fluidization.

For Run 17, the air was gradually removed from the gasifier as the acceptor activity increased due to replacement of the dead-burned dolomite. The acceptor circulation rate and the percent carbon burnoff were held constant. This mode of operation was based on mathematical model studies performed by Consolidation Coal's Library, Pennsylvania, Research group. The procedure allowed control of the showering inventory at all times without the need to defluidize the boot acceptor.

4.2 ACCOMPLISHMENTS

Data obtained during Run 17 are presented tabularly at the end of this run report. The plant operating conditions are summarized in Tables 17-1 through 17-4, while physical and chemical property data for the plant feedstocks, circulated acceptor, regenerator fuel char, and the gasifier and regenerator overhead solids are given in Tables 17-5 through 17-16.

Gas flow and solids circulation tests were conducted during both Runs 17A and 17B. In the gas flow tests, the gasifier and regenerator air orifices were checked against both vent orifices for consistency.

After evaluating the data and taking into account system leakage, the flow transmitters were re-zeroed, and the recorded flows were assumed to be correct.

The gasifier steam flow orifices were also checked using the recycle, purge, and air rates to the gasifier and the overhead steam/gas concentration. The results of these tests demonstrated that the steam flow orifice factors were accurate.

Dead-burned dolomite circulation tests were performed in the same manner as those conducted during Run 16. The results are shown in Figure 17-1 with the circulation rate correlated as a function of the pressure drop across the upper 34 feet of transfer line. These correlations are a valuable operating aid providing the only independent means of checking the acceptor circulation rates determined from heat and material balances.

The small differences between the Run 17A and 17B acceptor circulation data are primarily due to two factors: the lift gas rate (60,470 SCFH for Run 17A and 56,950 SCFH for Run 17B); and to the ambient temperature. Generally, but not always, the higher the lift gas rate for a given set of conditions and solids circulation rate, the higher the pressure drop will be.

The ambient temperature affects the recorded pressure drop because of the density differences between the purge gas to the pressure sensing taps and the heated process gas (lift gas). This density difference coupled with the difference in pressure tap elevation generates a measurable fluid head or force which must be added to the pressure readings to obtain the correct pressure drop. The density difference affects only the absolute and not the relative pressure drop measurements. The following equation may be used to calculate this head or pressure differential:

$$\Delta p = \frac{g}{g_c}\left[\frac{M_1}{T_1} - \frac{M_2}{T_2}\right]\frac{P\Delta L}{R} \qquad (1)$$

Where; ΔL = Difference between high and low sides of the pressure taps, FT.
g = Acceleration of gravity, 32.2 FT/SEC^2
g_c = Newton's law converstion factor, 32.2 FT-LB/LB-force/SEC^2
M_1 = Mole weight of purge gas, LB/LB-mole
M_2 = Mole weight of process gas, LB/LB-mole
P = System pressure, LB/IN^2
ΔP = Pressure differential, LB/FT^2
T_1 = Purge gas temperature (ambient), ^oR
T_2 = Process gas temperature, ^oR
R = Gas constant, 10.73 (LB-force/IN^2) FT^3/(LB-mole)/^oR

An example which demonstrates the gas density effect is given in Appendix 17A, following the tables. A gross correction was made to account for the density effect by elevating the zero on the lift line differential pressure transmitter. However, no attempt was made to correct the transmitter zero for flight changes in the ambient temperature.

Due to the long periods of steady-state operation, Run 17 provided much information on fluidized bed behavior and on the system pressure balance. Differential pressure data for the regenerator and gasifier fluidized beds are presented in Figures 17-2, 17-3, 17-4, and 17-5. The figures show the pressure due to solids at various levels in the fluidized beds. These figures clearly show that the pressure drop per foot of bed is constant.

In the gasifier, two separate fluidized beds are maintained. These are: the recarbonated acceptor bed in the boot section; and the char bed. The location of the interface between these two beds is identified as the point of slope change in Figures 17-2 and 17-4. The apparent (not expanded) bed height in each reactor is found to be the intersection of the curves with the abscissa. The expanded beds often surge to heights much greater than the apparent bed level. However, reliable material withdrawal at high rates can only be maintained if the apparent bed level is at or above the withdrawal point.

The system pressure balance is shown in Figure 17-6 for the period just prior to the Run 17B shutdown. The elevation and pressures at 15 points throughout the system are shown. The values indicated are differential pressure with respect to point 1. At all times the pressure at point 1 is controlled at 150 PSIG.

Above each standleg control valve, purge gases (balance gases) are supplied to regulate the pressure drop across the valves. This standleg balance gas system provides effective gas seals between reactors so gases from one reactor do not leak into the other. By proper adjustment of the balance gas rates, the pressure drop across the valves due to the gas flow can be controlled at zero. However, as shown in Figure 17-6, all pressures were controlled to insure purge gas flow from the valves to the gasifier. This provided a measure of safety by eliminating the chances of steam condensation caused by backflushing into the standlegs should the solids circulation stop. Ultimately, to provide an effective gasifier nitrogen barrier, the balance gas purges will have to be reduced.

Probably the major accomplishment of Run 17 was the ability to control the char bed density while showering acceptor. This control was achieved by reducing the gasifier char particle density. The fixed carbon burnout was targeted for 56 percent. Although only a 52 percent burnout was obtained, the gasifier char bed density remained in a stable

regimen even at the higher acceptor showering rates of 11,000 to 12,000 LBS/HR. At all times, the boot gas flow was sufficient to incipiently fluidize the collected acceptor. Previously when acceptor retention caused excessive char bed densities, the gasifier boot gas flow was reduced to improve the showering.

The char bed density performance at various acceptor circulation rates is shown in Tables 17-1 and 17-3. The corresponding acceptor circulation rates reported in Tables 17-2 and 17-4 were determined from the lift line pressure drop correlations.

4.3 PROBLEMS

System pressure upsets were periodically experienced due to the operation of the gasifier quench system. One such pressure upset during Run 17A caused the loss of the char-acceptor interface. This upset resulted from excessive quench water carryover into the compressor suction knockout pot. The water carryover was probably caused by solids accumulation in the bottom dished head of the gasifier quench tower. The solids eventually plugged the liquid discharge line between the quench tower and the solids separator which in turn caused flooding of the quench tower. Correction of this problem will require some quench system modifications. Various system changes are now being considered.

Following Runs 17A and 17B, two types of deposits were found in the bottom of the regenerator. The first type from Run 17A was composed primarily of agglomerated dead-burned dolomite. The other type found after Run 17B was an agglomerate of acceptor, char ash, and possibly sand particles.

The deposits were located in the regenerator bottom head forming a steeper cone and behind the air distributor ring. Neither deposit obstructed the solids or gas inlet lines to the regenerator. However, since the deposits may have affected the gas distribution, they were removed after each run.

A small deposit composed of dead-burned dolomite was also found in the gasifier boot cone section following Run 17A. Neither the regenerator nor gasifier cone deposits were observed in earlier runs before the use of dead-burned dolomite as a startup material. Apparently, both the geometry of the bottom heads and the physical properties of the dead-burned dolomite contribute to the first type deposit formation.

The second type of deposit appears to be due to char ash slagging and to the accumulation of high silica components in the vicinity of the regenerator air distributor ring. Chemical analyses for several fractions of the Run 17B deposit are shown in Table 17-17.

The frequent temperature excursions experienced during Run 17B may have contributed to this deposit formation. These excursions resulted when fresh acceptor makeup addition was stopped to recharge the makeup lockhopper. Although efforts were made to taper off the makeup rate prior to recharging the hopper, temperature upsets continued to occur.

These temperature upsets may also help explain the relatively low acceptor activity of 0.16 attained after 72 hours of fresh acceptor makeup. However, due to the premature Run 17B shutdown, no variable study of the factors affecting activity could be made.

Fresh acceptor makeup to replace the dead-burned dolomite was delayed 30 hours because of a plugged line between the gasifier and the purged acceptor lockhopper. A wet acceptor plug formed when backflushed steam from the gasifier condensed in this water jacketed line.

A major upset occurred when the plug was partially broken by blowing with a large flow of inert gas. The interface was lost. Loss of acceptor circulation resulted in high regenerator temperature. The interface was regained and run conditions were reestablished.

The withdrawal lockhopper plug was eventually broken after replacing the cooling water with steam, by a combination of rodding and blowing. When the plug broke, the withdrawal flow could not be controlled by the butterfly valve in the system since the valve was stuck in the open position because of a bent shaft. Before control of withdrawal could be established using the lockhopper ball valve, the regenerator level became dangerously low. To regain level, a makeup rate of 1,500 LBS/HR was established. In an effort to adjust the regenerator temperature for this large increase in duty, a large amount of air was added and a temperature overshoot occurred.

After the plug occurred, two modifications were made to prevent future plugs in the withdrawal lockhopper system. They were: (1) a positive purge through the shaft of the butterfly valve; and (2) a differential pressure instrument showing the pressure drop between the butterfly valve and the bottom of the gasifier. Gas backflushing was avoided by adjusting the purge to keep the pressure at a butterfly valve above that in the gasifier.

Two methods were investigated for determining the percent acceptor present in the gasifier char bed and the regenerator fuel char. The methods involved either an elutriation or a float-sink technique to physically separate the char from the acceptor. Neither method proved satisfactory since light acceptor particles were always present in the char fraction. To obtain accurate data, the last Run 17B char bed sample was separated at Consolidation Coal Company's Library Research Center. An exhaustive technique of microscopic examination and hand picking was used. Since this was the only truly separated gasifier char bed sample, no ultimate or elemental analyses are reported for the

regenerator fuel chars in this report. However, a memorandum will be issued later covering the analysis of the meticulously separated sample. From the data and consideration of the gasifier overhead solids, the fixed carbon burnoff was determined to be 52 percent.

Since the manual separation procedure is too time consuming, alternate means of determining the percent acceptor are being investigated by the plant laboratory.

Sulfur corrosion in the gasifier boot recycle gas heaters, B-201-IA and B-201-IIA, was a serious problem in earlier runs. This attack has apparently been eliminated by the use of the new zinc oxide sulfur removal system ahead of the heaters. However, another form of corrosion was found to be occurring when during Run 17A the boot recycle gas heater convection coil, B-201-IIIA, ruptured. Inspection of the IIIA and IIA coils revealed extensive metal pitting. The IIIA coil was replaced with an identical coil from the devolatilizer recycle gas heater, B-207-IIIA. The IIA coil was bypassed since the IA coil could alone provide the necessary gas preheat (see Figure 17-7 for the heater configuration). Following Run 17B, inspection of the replacement IIIA coil showed that the tube walls had thinned in some areas as much as 0.04 inches. This thinning may have been the result of an uncertain history prior to installation in the gasifier service. Before Run 17C, the coil was again replaced with a new coil of alonized type 304 stainless steel.

Metallurgists have indicated that the corrosive attack is a form of metal dusting. Metal carbides resulted from reactions involving the tube walls and some or all the carbon containing constituents of the recycle gas (i.e., CO, CO_2 and CH_4). Carbon then deposits at the metal grain boundaries. Once the carbon is formed, the metal grains were gradually forced (popped) out of the metal surface. Successive metal grain losses eventually resulted in observable pits. Various types of corrective actions are being considered to eliminate the corrosion. These include: (1) changing the heater tube metallurgy; (2) use of steam to provide a protective oxide film layer; and (3) use of metered quantities of sulfur to provide a protective sulfide film.

During Run 16, excessive erosion occurred in the engager pot which had been modified to reduce acceptor attrition and in the acceptor lift line inner pipe. The engager pot was again modified prior to Run 17A. The new design provided a foot deep fluidized bed into which the recarbonated and fresh acceptor makeup dropped before being lifted to the regenerator. Inspection of the engager pot following Run 17A showed that no noticeable erosion of the engager pot internals had occurred.

The lift line erosion which occurred during Run 16 was in the bell-shaped expansion joints and at points of pipe misalignment. The pipe was repaired and the joints were replaced prior to Run 17A with ones having a 2.4 degree taper and internally coated with chrome carbide. Because the chrome carbide coating eroded away during Run 17A,

the slip joints were replaced with ones coated with a .050 inch thick layer of nickel aluminide. This material also eroded away, therefore the slip joints were again replaced. This time the cones were internally coated with stellite. These have not been thoroughly tested since Run 17C lasted only a few hours.

In the plant, the regenerator fuel char, calcined acceptor, and spent acceptor are transferred between vessels through double walled pipes. The inner pipe contains the hot materials while the outer pipe is used as a pressure jacket. The two concentric pipes are separated by vacuum formed Kaowool insulation.

During the run, hot spots developed on several of the double walled lines. For Run 17A, an insulation failure was responsible for the two hot spots which appeared on the calcined acceptor standleg, CD-206. The failure of a pressure tap connection into the inner pipe on CD-206 and the failure of the conical end plates on acceptor lift line, CD-208, created hot spots during Run 17B.

As a safety measure, all double walled lines are painted with a heat sensitive paint which changes color from blue to white at 400^{o}F. This provides an early warning of internal problems which could result in overheating the external pressure containing lines. Once discovered, the hot spots are continually monitored, and, if necessary, low pressure steam is used for cooling.

Plugging of the regenerator quench tower inlet had been a serious problem in earlier runs. Acceptor and char ash fines would cement together at the tower inlet where the quench tower water first contacted the regenerator flue gases. Eventually, the solids buildup caused excessively high pressure drops accross the quench system.

To eliminate the problem, several quench tower inlet designs and the use of horizontal and vertically positioned venturi ahead of the quench tower were tested. The vertically positioned venturi was the only successful design.

During these test series, a mechanical cleaning and scrubbing device was installed in parallel with the vertical venturi. This device is described in Run 13 Report. Briefly, the device consists of an 11-foot long 3-inch diameter pipe in which a rod with metal spikes is rotated. Flue gases enter the pipe at the top and exit out the bottom to the quench tower after being contacted with water. Periodically, the spiked shaft is rammed up and down inside of the 3-inch diameter pipe to remove solids from the spikes and pipe walls.

Between Runs 17A and 17B, a 4-inch diameter device replaced the 3-inch diameter one. However, neither unit has operated satisfactorily. At the end of Run 17A, the vertical venturi and the regenerator quench tower inlet were found to be free of solids while the mechanical device

was found to be plugged with a 3-inch diameter by 4-inch long solids agglomeration at the water inlet. At the end of Run 17B, the 4-inch diameter unit was totally plugged. Solids were also found at inlets to the quench tower and the venturi. However, these solids accumulations probably resulted from the upset experienced during shutdown, whereas the plugging of the mechanical cleaning device occured during the run. Plans are to remove the mechanical cleaning device and to install another vertical venturi in parallel with the existing one. Appropriate piping will be included so that either venturi can be removed from the system and cleaned during a run.

5 FUTURE PLANS

The program for Run 18 is essentially the same as that for Run 17. The objectives include:

(1) Achievement of operating conditions, that is, no air to gasifier.

(2) Introduction of lignite as a feedstock.

(3) Study factors affecting acceptor activity in the plant.

(4) Achievement of long-term, steady-state plant operation.

Due to the plugging experienced with the calcined acceptor stand-leg during Run 17C, spent acceptor will not be used as a startup material. Dead-burned dolomite will be used for the initial regenerator inventory.

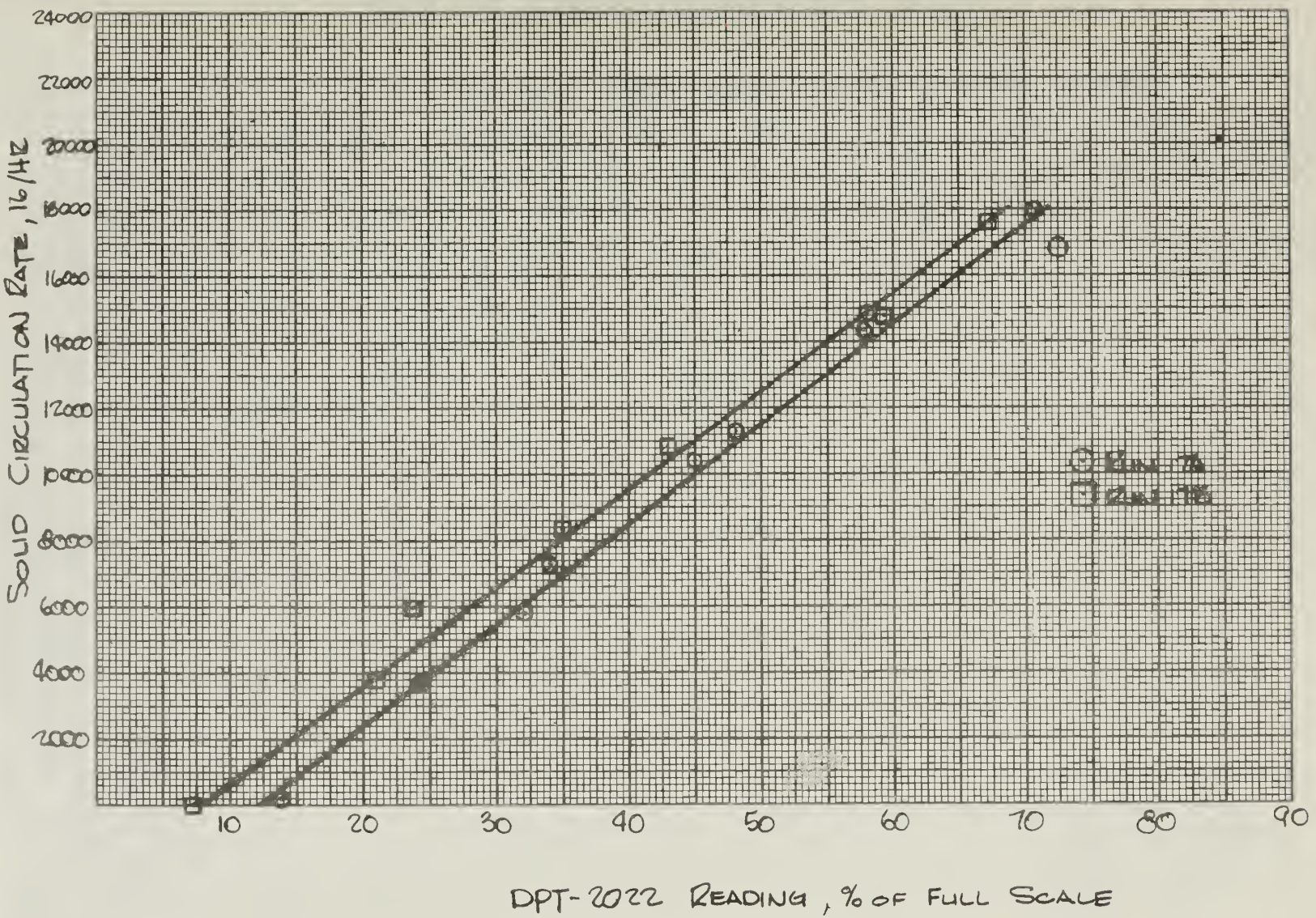


Figure 17-1. SOLIDS CIRCULATION RATE AS A FUNCTION OF LIFT LINE PRESSURE DROP, RUN 17A AND 17B

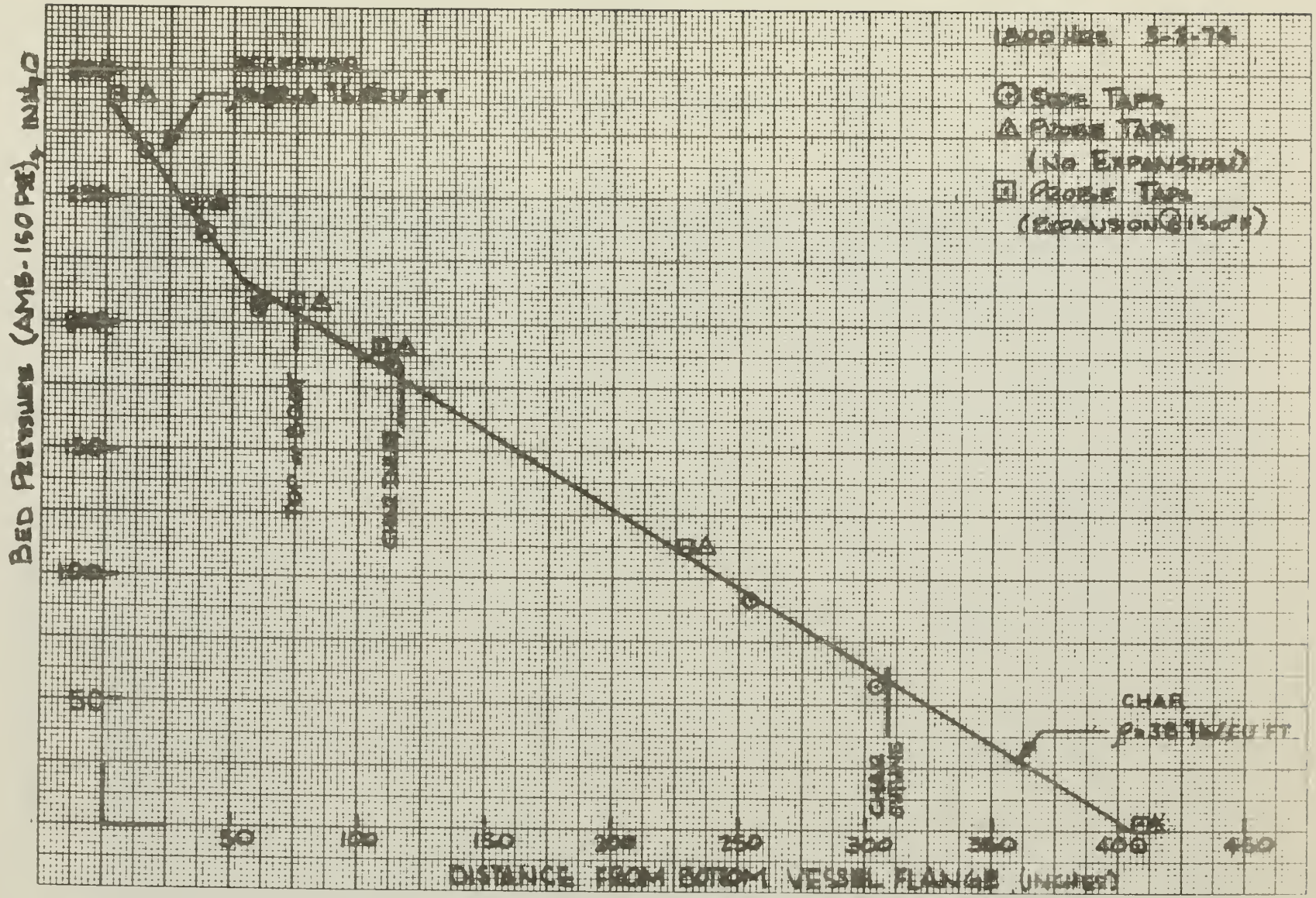


Figure 17-2. GASIFIER PRESSURE PROFILE, RUN 17A

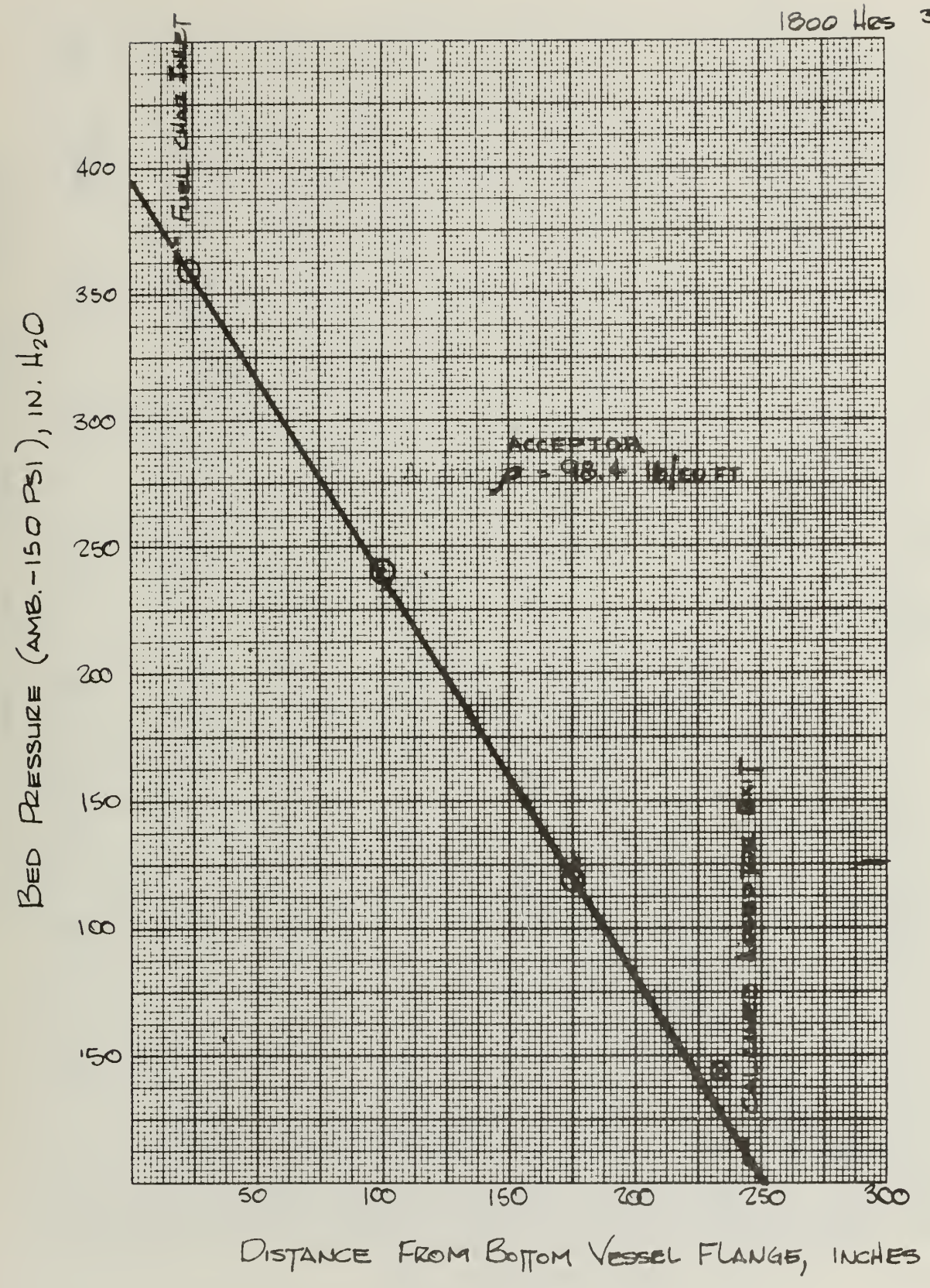


Figure 17-3. REGENERATOR PRESSURE PROFILE, RUN 17A

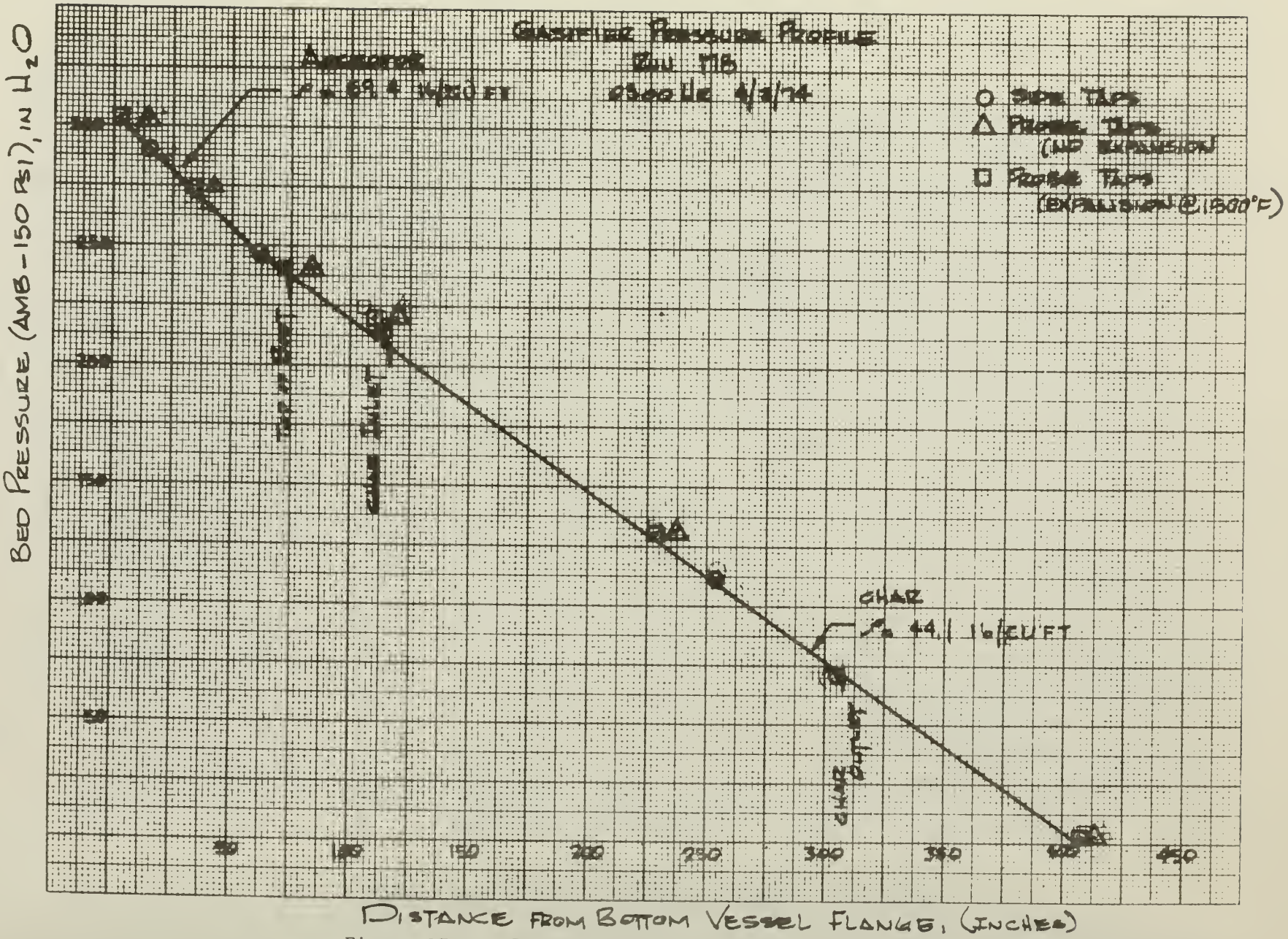


Figure 17-4. GASIFIER PRESSURE, PROFILE, RUN 17B

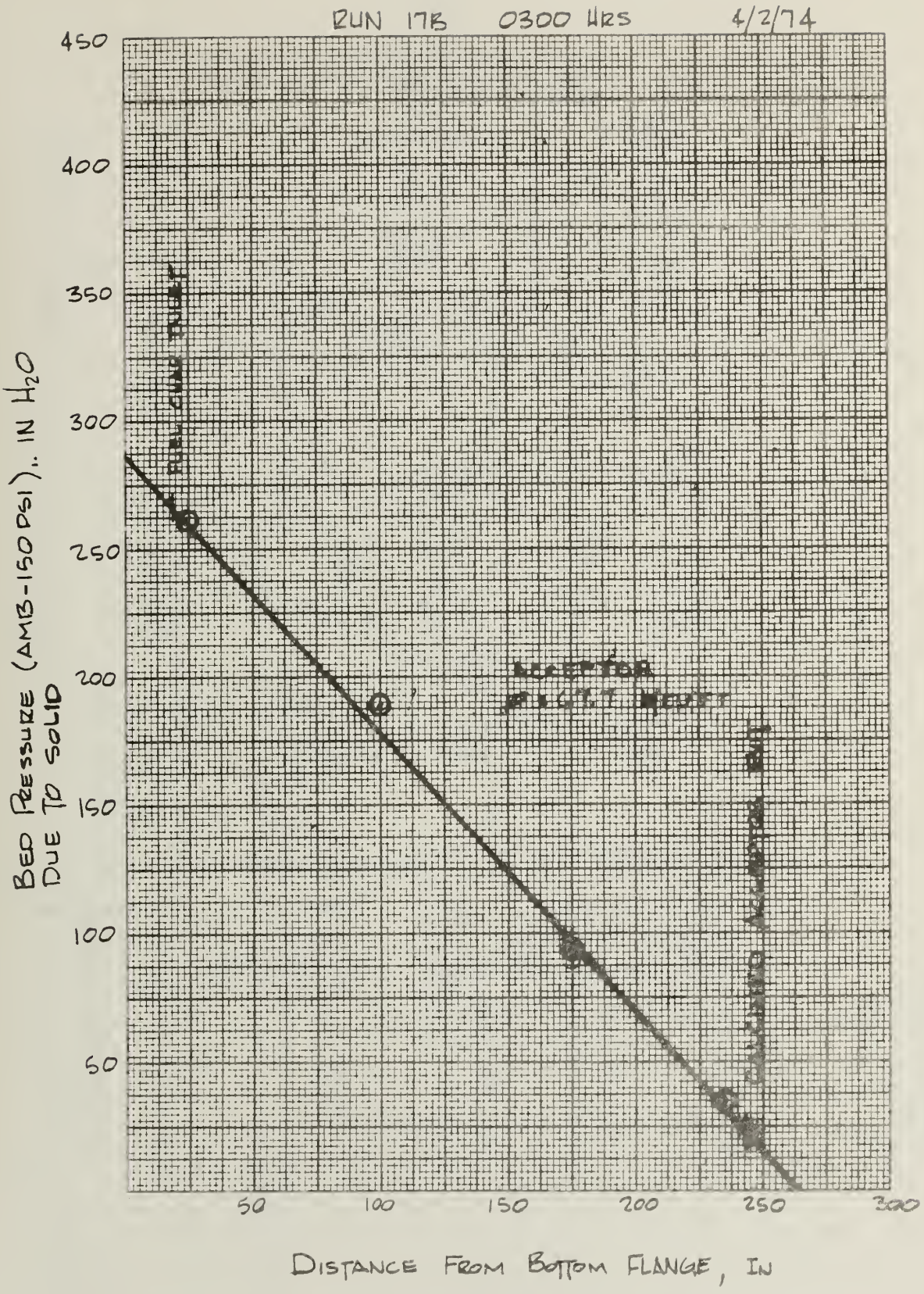
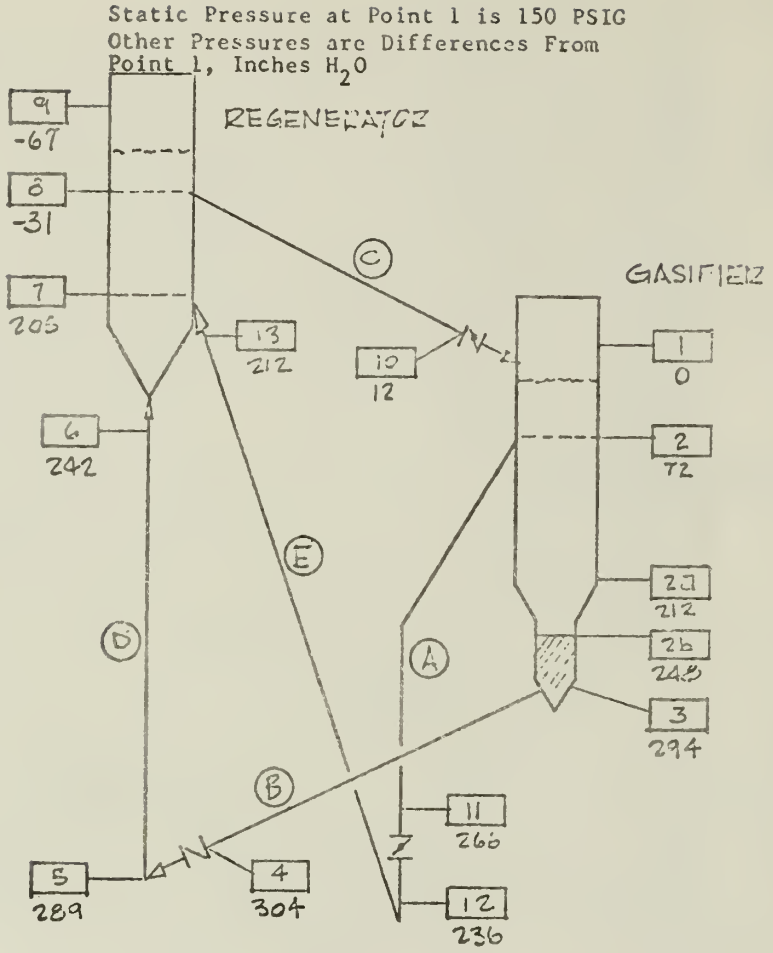


Figure 17-5. REGENERATOR PRESSURE PROFILE, RUN 17B



PRESSURE DROPS ACROSS STANDLEGS, BUTTERFLY VALVES, AND LIFT LINES

Data from Run 178, 0000-0300 Hours, April 2, 1974

(See Tables 3 and 4 for Run Conditions)

	Point Numbers	I.D., Inches	ΔP, Inches H_2O
Standlegs			
A (fuel char)	11-2	3	194
B (spent acceptor)	4-3	4	10
C (regenerated acceptor)	10-8	4	43
Butterfly Valves			
Fuel char	11-12	2	30
Spent acceptor	4-5	4	13
Regenerated acceptor	10-9	4	12
Lift Line			
D (spent acceptor)	5-6	4	47
E (fuel char)	12-13	2	24

ELEVATIONS ARE DISTANCES ABOVE THE LOW END OF THE ACCEPTOR LIFT LINE

Point	Elevation, feet
1	89.0
2	56.7
2a (Lignite inlet)	40.7
2b (Interface level)	35.9
3	32.9
4	8.6
5	0
6	92.9
7	102.3
8	121.2
9	130.2
10	86.5
11	7.5
12	5.6
13	105.8

Figure 17-6. PRESSURE BALANCE DIAGRAM

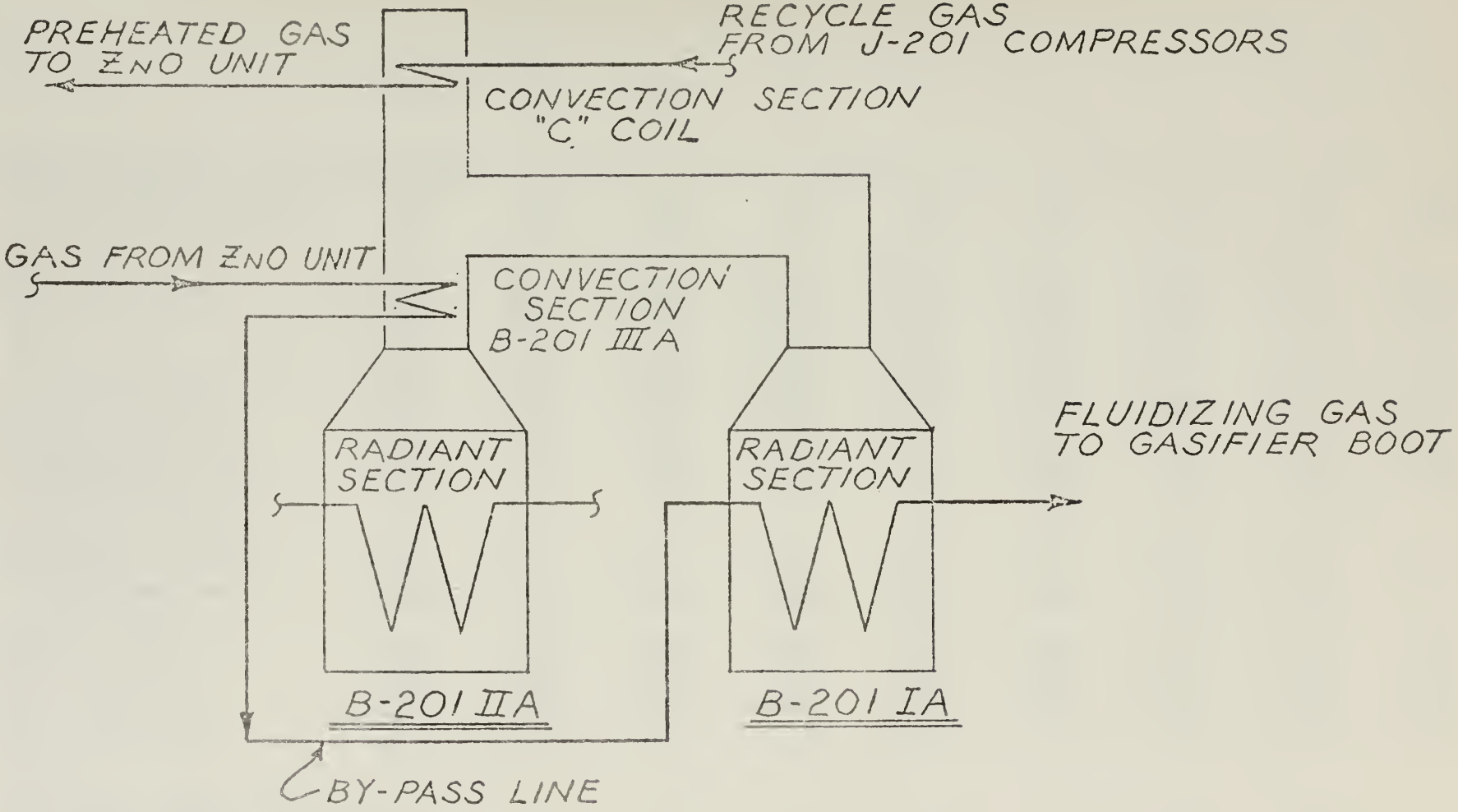


Figure 17-7. GASIFIER BOOT FLOW RECYCLE GAS HEATER CONFIGURATION

Date	2/28/74			3/1/74			3/2/74		
Time	0700	1500	2300	0700	1500	2100	0500	1300	1700
Jacket Steam Make, lb/hr	0	0	0	0	0	0	0	0	0
Solids									
Feedstock					Husky Char				
Feed Rate, lb/hr	1,167	1,093	1,154	1,182	1,162	1,380	1,357	1,371	1,135
Heating Value (DuLong), Btu/lb					11,711				
Dump Acceptor, lb/hr	327	188	188	189	189	189	189	0	0
Gas Flow(1)									
Boot (Recycle), SCFH	24,100	22,900	26,000	22,700	23,800	26,400	26,500	25,500	26,500
Boot (Steam), SCFH	0	0	0	0	0	0	0	0	0
Steam to Side, SCFH	37,100	40,500	40,200	40,200	40,100	46,400	46,300	46,400	47,200
Air to Side, SCFH	22,800	17,400	17,800	14,900	14,400	17,400	17,500	17,700	17,600
Total Flow In, SCFH	84,000	80,800	84,000	77,800	78,300	90,200	90,300	89,600	91,300
Vent Rate, SCFH	43,100	35,600	36,000	38,300	37,500	41,600	41,600	43,700	43,000
Purges									
Recycle, SCFH	3,920	3,950	4,190	4,220	4,320	4,250	4,770	4,220	4,240
Inert, SCFH	400	400	400	400	400	400	400	400	400
Bed Conditions									
Boot Velocity, ft/sec	1.27	1.23	1.41	1.22	1.28	1.42	1.43	1.37	1.43
Char Bed Velocity Inlet, ft/sec	.96	.93	.98	.91	.91	1.04	1.05	1.03	1.05
Boot Density, lb/ft^3(2)	68	67	64	62.5	61	58	59	57	57
Char Bed Density, lb/ft^3(2)	34	37.5	38	38.5	39	40	39	39	39
Boot Temperature, °F	1480	1520	1530	1525	1515	1520	1520	1515	1520
Char Bed Temperature, °F	1510	1530	1540	1550	1530	1535	1530	1525	1530
Overhead Gas Composition, Mol %									
O_2	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	17.4	12.6	16.5	17.1	13.0	15.5	16.6	16.8	16.6
CO_2	17.7	16.1	15.2	15.4	12.3	15.2	15.8	15.5	15.5
N_2	41.1	48.0	34.2	31.8	37.0	33.0	32.0	32.0	31.4
H_2	20.2	21.3	30.8	32.0	33.4	33.0	31.8	31.8	32.9
CH_4	3.2	1.9	3.3	3.6	4.25	3.3	3.7	3.8	3.5
H_2O Mol Fraction	-	-	-	-	-	-	-	-	-

(1) Determined by orifice flow meter measurements
(2) Densities indicated by pressure tap readings

Table 17-1. GASIFIER DATA, RUN 17A

Date	2/28/74			3/1/74			3/2/74		
Time	0700	1500	2300	0700	1500	2100	0500	1300	1700
Jacket Steam Make, lb/hr	200	300	280	280	280	310	340	260	280
Solids									
Acceptor Feedstock	Dead-Burned Dolomite								
Acceptor Makeup, lb/hr	173	216	206	204	190	183	292	187	187
Acceptor Circulation, lb/hr[1]	3,200	4,500	5,700	7,800	7,500	7,800	8,100	9,400	10,800
Ash & Attrited Acceptor, lb/hr[2]	115	78	55	75	90	60	82	62	83
Gas Flows[3]									
Acceptor Lift, SCFH	54,400	55,200	54,300	55,000	54,500	54,700	54,400	55,000	55,000
Char Lift, SCFH	7,440	7,110	7,180	7,310	7,230	7,240	7,110	7,050	7,050
Air Line									
Recycle, SCFH	70,700	29,400	29,300	24,000	28,900	28,400	28,800	28,800	28,300
Air, SCFH	28,800	40,400	45,600	41,900	44,400	45,500	45,400	44,300	43,400
Total Flow In, SCFH	161,340	132,110	136,380	128,210	135,030	135,840	135,810	135,150	133,750
Vent Rate, SCFH	34,000	45,200	53,300	55,100	54,900	56,300	52,200	56,300	53,500
Purges									
Recycle, SCFH	425	424	424	425	427	427	426	427	427
Inert, SCFH	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530
Nitrogen, SCFH	854	854	854	854	854	854	854	854	854
Bed Conditions									
Gas Velocity Inlet, ft/sec	2.64	2.44	2.56	2.41	2.52	2.55	2.55	2.52	2.49
Bed Density, lb/ft^3[4]	59-79	57-72	55-70	55-70	54-69	54-70	53-68	53-67	53-69
Average Bed Temperature, °F	1560	1820	1850	1860	1845	1855	1855	1846	1835
Overhead Gas Analysis, Mol %									
O_2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
CO	0.0	2.1	1.5	1.0	3.2	2.9	2.2	3.0	3.5
CO_2	17.6	18.6	18.4	17.6	16.0	15.6	16.4	16.0	15.6
N_2	82.4	79.3	80.1	81.5	80.8	81.3	81.4	81.0	80.9
H_2									
CH_4									

(1) Determined by lift line pressured drop measurements
(2) Determined by weigh scale measurements
(3) Determined by orifice flow meter measurements
(4) Density indicated by pressure tap readings

Table 17-2. REGENERATOR DATA, RUN 17A

Date	3/26/74		3/27/74			3/28/74			3/29/74		
Time	1900	2300	0700	1500	2210	0700	1500	2300	0700	1500	2300
Jacket Steam Make, lb/hr	0	0	0	0	0	0	0	0	0	0	0
Solids											
Feedstock	Husky Char										
Feed Rate, lb/hr	946	1,091	1,124	1,154	1,204	1,142	1,350	1,092	1,074	1,073	1,166
Heating Value (DuLong), Btu/lb	12,610										
Dump Acceptor, lb/hr	194	194	138	138	197	197	197	116	116	116	116
Gas Flows[1]											
Boot (Recycle), SCFH	20,200	20,300	20,300	20,800	20,600	19,000	19,100	19,300	25,500	24,400	24,300
Boot (Steam), SCFH	0	0	5,360	6,770	6,550	8,440	8,690	7,720	0	0	0
Steam to Side, SCFH	23,700	24,100	24,200	28,800	29,300	29,400	30,000	30,500	45,100	39,700	40,300
Air to Side, SCFH	18,500	18,800	19,200	13,700	16,100	14,600	14,500	14,700	10,300	12,600	12,600
Total Flow In, SCFH	62,400	63,200	69,060	70,100	72,550	71,440	72,290	72,220	80,900	76,700	77,200
Vent Rate, SCFH	31,200	32,800	34,300	29,700	31,400	29,900	34,000	31,900	25,500	27,300	26,300
Purges											
Recycle, SCFH	4,170	4,170	4,160	4,280	4,300	4,300	4,350	4,280	4,370	4,300	4,280
Inert, SCFH	400	400	400	400	400	400	400	400	400	400	400
Bed Conditions											
Boot Velocity, ft/sec	1.08	1.09	1.37	1.45	1.45	1.46	1.49	1.46	1.36	1.31	1.30
Char Bed Velocity lnlet, ft/sec	.73	.79	.81	.82	.84	.83	.84	.85	.94	.89	.89
Boot Density, lb/ft^3[2]	61	61	60	58	58	56	57	57	57	56	56
Char Bed Density, lb/ft^3[2]	40	39.5	38	40	40.5	42.5	42	40.5	40	40	41.5
Boot Temperature, °F	1510	1520	1510	1515	1500	1500	1505	1525	1505	1515	1500
Char Bed Temperature, °F	1520	1530	1535	1540	1520	1520	1525	1540	1520	1525	1525
Overhead Gas Composition, Mol %[3]											
O_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	16.7	17.9	17.2	16.0	16.4	18.0	15.7	18.2	17.0	17.6	17.3
CO_2	13.9	13.4	13.2	12.8	13.7	13.9	12.4	14.6	16.3	14.7	15.4
N_2	37.3	36.5	38.2	35.2	32.4	30.9	33.5	30.0	24.5	29.8	29.0
H_2	29.3	29.2	28.6	33.2	34.4	34.4	35.1	33.9	38.1	34.8	34.0
CH_4	2.7	2.9	2.8	2.7	3.0	2.8	3.2	3.3	4.1	3.0	4.2
H_2O Mol Fraction	15.9	21.0	20.6	21.6	22.7	23.7	23.0	24.1	24.0	24.1	24.7

(1) Determined by orifice flow meter measurements
(2) Densities indicated by pressure tap readings
(3) Moisture free

Table 17-3. GASIFIER DATA, RUN 17B (Sheet 1 of 2)

Date	3/30/74			3/31/74			4/1/74			4/2/74
Time	0700	1500	2300	0700	1500	2300	0700	1500	2300	0300
Jacket Steam Make, lb/hr	0	0	0	0	0	0	0	0	0	0
Solids										
Feedstock	Husky Char									
Feed Rate, lb/hr	1,162	1,307	1,384	1,429	1,219	1,440	1,219	1,041	1,185	1,326
Heating Value (DuLong), Btu/lb	12,610									
Dump Acceptor, lb/hr	228	468	314	298	286	290	299	161	-	-
Gas Flows[1]										
Boot (Recycle), SCFH	25,100	27,400	23,700	23,900	23,500	23,200	22,600	26,700	25,700	26,100
Boot (Steam), SCFH	0	0	0	0	0	0	0	0	0	0
Steam to Side, SCFH	40,200	48,600	50,400	50,500	52,800	54,600	54,400	55,100	55,200	55,100
Air to Side, SCFH	12,700	8,350	9,190	10,800	7,190	7,420	7,830	0	0	0
Total Flow In, SCFH	78,000	84,350	83,290	85,200	83,490	85,220	84,830	81,800	80,900	81,100
Vent Rate, SCFH	24,100	20,600	22,800	25,600	22,900	21,700	20,100	12,000	10,100	10,200
Purges										
Recycle, SCFH	4,410	4,720	4,630	4,840	4,820	4,940	4,960	5,450	5,500	5,540
Inert, SCFH	400	400	400	400	400	400	400	400	400	400
Bed Conditions										
Boot Velocity, ft/sec	1.35	1.47	1.28	1.28	1.26	1.24	1.21	1.42	1.38	1.38
Char Bed Velocity Inlet, ft/sec	.91	.98	.97	.99	.97	.99	.98	.95	.94	.95
Boot Density, lb/ft^3[2]	52	50	47	47	45.5	43	43	42	41	41
Char Bed Density, lb/ft^3[2]	41	42.5	41	41	41	41	42	44	46.5	47.5
Boot Temperature, °F	1520	1510	1515	1510	1515	1500	1505	1500	1495	1495
Char Bed Temperature, °F	1530	1520	1530	1520	1530	1520	1520	1515	1510	1520
Overhead Gas Composition, Mol %[3]										
O_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	16.8	14.1	13.4	13.4	13.6	12.8	13.0	11.9	12.7	12.9
CO_2	12.3	11.6	11.5	11.1	11.1	11.0	11.0	9.5	9.6	9.4
N_2	29.3	22.8	25.9	21.1	21.4	18.7	17.9	10.0	7.6	6.5
H_2	36.3	45.0	44.6	44.6	47.4	50.0	50.4	59.1	59.4	60.0
CH_4	5.2	6.4	6.6	6.8	6.4	7.5	7.6	9.5	10.6	11.2
H_2O Mol Fraction	17.1	28.2	27.1	28.6	29.0	29.4	30.9	34.5	31.7	31.1

(1) Determined by flow meter measurements
(2) Densities indicated by pressure tap readings
(3) Moisture free

Table 17-3. GASIFIER DATA, RUN 17B (Sheet 2 of 2)

Date	3/26/74		3/27/74			3/28/74			3/29/74		
Time	1900	2300	0700	1500	2210	0700	1500	2300	0700	1500	2300
Jacket Steam Make, lb/hr	270	300	320	360	350	350	350	340	350	350	350
Solids											
Acceptor Feedstock	Dead Burned Dolomite										
Acceptor Makeup, lb/hr	355	178	178	178	178	178	178	0	0	0	0
Acceptor Circulation, lb/hr(1)	4,800	5,200	5,000	7,100	8,000	11,000	11,000	11,000	11,600	11,600	11,000
Ash & Attrited Acceptor, lb/hr(2)	85	30	53	53	68	85	50	59	90	70	80
Gas Flows(3)											
Acceptor Lift, SCFH	55,900	56,500	57,000	56,800	56,500	57,700	51,900	52,600	52,300	52,000	52,200
Char Lift, SCFH	7,460	7,490	7,470	7,340	7,470	7,460	7,320	7,220	7,440	7,390	7,460
Air Line											
Recycle, SCFH	31,500	31,500	31,800	35,200	34,500	33,500	30,600	28,500	29,700	29,000	28,600
Air, SCFH	47,300	46,500	46,300	49,100	53,700	53,600	52,500	51,900	52,500	49,900	51,100
Total Flow In, SCFH	142,360	141,990	142,570	148,440	152,120	152,260	142,320	140,220	141,940	138,290	140,360
Vent Rate, SCFH	50,400	46,200	50,600	51,400	56,000	60,900	56,500	51,400	49,900	55,300	53,400
Purges											
Recycle, SCFH	423	424	425	425	428	426	425	428	426	425	426
Inert, SCFH	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530
Nitrogen, SCFH	854	854	854	854	854	854	854	854	854	854	854
Bed Conditions											
Gas Velocity Inlet, ft/sec	2.64	2.65	2.67	2.77	2.84	2.83	2.65	2.61	2.64	2.59	2.61
Bed Density, lb/ft^3(4)	54-70	55-69	54-68	54-67	52-70	54-69	54-68	54-67	55-68	55-67	53-66
Average Bed Temperature, °F	1835	1845	1850	1840	1840	1830	1835	1840	1840	1850	1835
Overhead Gas Analysis, Mol %											
O_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	2.0	3.0	2.8	2.6	3.6	4.3	2.9	2.5	2.8	2.6	3.0
CO_2	19.2	18.8	18.0	17.6	16.0	16.4	17.2	14.8	16.8	17.2	16.8
N_2	78.8	78.2	79.2	79.8	80.4	79.3	79.9	82.7	80.4	80.2	80.2

(1) Determined by lift line pressure drop measurements
(2) Determined by weigh scale measurements
(3) Determined by orifice flow meter measurements
(4) Density indicated by pressure tap readings

Table 17-4. REGENERATOR DATA, RUN 17B (Sheet 1 of 2)

Date	3/30/74			3/31/74			4/1/74			4/2/74
Time	0700	1500	2300	0700	1500	2300	0700	1500	2300	0300
Jacket Steam Make, lb/hr	320	310	320	315	315	300	300	310	310	310
Solids										
Acceptor Feedstock	Dead Burned Dolomite			Tymochtee Dolomite						
Acceptor Makeup, lb/hr	590	590	710	850	430	590	590	590	590	590
Acceptor Circulation, lb/hr[1]	10,100	9,500	12,200	10,800	10,100	10,100	10,400	11,900	12,500	12,200
Ash & Attrited Acceptor, lb/hr[2]	165	185	305	300	143	153	120	180	105	150
Gas Flows[3]										
Acceptor Lift, SCFH	51,400	51,800	51,400	51,400	51,600	51,400	51,300	50,900	50,900	50,700
Char Lift, SCFH	7,460	7,260	7,280	7,420	7,390	7,380	7,370	7,410	7,310	7,310
Air Line										
Recycle, SCFH	26,800	14,100	22,700	23,200	11,100	3,000	3,000	0	0	0
Air, SCFH	59,400	60,200	74,000	68,700	64,100	67,000	69,500	65,100	67,600	68,900
Total Flow In, SCFH	145,000	133,360	155,380	150,720	134,190	138,780	131,170	123,410	125,810	126,910
Vent Rate, SCFH	70,500	72,100	89,200	84,700	70,600	80,700	83,400	79,800	81,700	81,300
Purges										
Recycle, SCFH	419	421	419	421	420	419	419	417	418	418
Inert, SCFH	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530
Nitrogen, SCFH	854	854	854	854	854	854	854	854	854	854
Bed Conditions										
Gas Velocity Inlet, ft/sec	2.71	2.48	2.89	2.82	2.51	2.39	2.47	2.31	2.37	2.40
Bed Density, lb/ft^3[4]	48-63	48-63	40-56	43-60	44-58	41-55	43-56	41-69	41-54	41-53
Average Bed Temperature, °F	1840	1840	1835	1850	1845	1835	1870	1855	1865	1870
Overhead Gas Analysis, Mol %										
O_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	1.8	4.2	4.3	2.6	2.4	5.0	3.4	2.4	3.1	2.4
CO_2	22.8	21.6	22.8	21.6	22.4	23.6	22.8	25.4	24.0	24.0
N_2	75.4	74.2	72.9	75.8	75.2	71.4	73.8	72.2	72.9	73.6

(1) Determined by lift line pressure drop measurements
(2) Determined by weigh scale measurements
(3) Determined by orifice flow meter measurements
(4) Density indicated by pressure tap readings

Table 17-4. REGENERATOR DATA, RUN 17B (Sheet 2 of 2)

Date 2/22 - 3/2 Run 17A

	Dolomite		Char
Screen Size, Wt % Tyler Mesh	Conditioned Acceptor	Dead Burned Dolomite	Screen Size, Wt % Tyler Mesh	
+4	0.5	0	+6	0
4 X 6	0.9	Tr	6 X 8	0
6 X 8	31.9	0.1	8 X 10	1.2
8 X 9	27.5	0.1	10 X 14	11.3
9 X 10	22.8	2.0	14 X 20	15.8
10 X 12	11.0	16.7	20 X 28	18.2
12 X 14	4.0	27.3	28 X 35	15.5
14 X 16	0.8	23.3	35 X 48	14.7
16 X 20	0.2	19.5	48 X 65	9.8
20 X 24	0.1	5.8	65 X 100	5.3
24 X 28	Tr	1.7	100 X 200	6.0
-28	0.3	3.5	-200	2.2
Particle Density, lb/cu ft	163.8	201.2		77.1
Ultimate Analysis, Wt %(1)				
Moisture				0.03
C				74.92
H				2.35
N				0.76
S				1.94
Ash + SO_3				15.22
Elemental Analysis, Wt %(2)				
SiO_2	5.37	0.41(3)		22.00
CaO	52.81	59.16		25.58
MgO	38.01	37.67		7.89
Na_2O	0.05	0.07		1.42
Fe_2O_3	0.81	1.73		4.40
Al_2O_3	1.69	0.40		11.00
P_2O_5	0.07	0.01		0.03
TiO_2	0.05	0.15		0.63
K_2O	0.23	0.03		0.21
SO_3		-		26.23
Total S	0.30	0		
Sulfide	0.21	-		

(1) As received basis
(2) On calcined basis or total ash basis
(3) Dead burned analysis of November 20, 1973

Table 17-5. FEEDSTOCK COMPOSITES, RUN 17A

Date 3/15 - 4/2 Run 7B

	Dolomite		Char	
Screen Size, Wt % Tyler Mesh	Conditioned Stone(1)	6 X 9	Screen Size, Wt % Tyler Mesh	
+4	0	0.3	+6	0
4 X 6	0	0.9	6 X 8	0
6 X 8	0.4	24.1	8 X 10	2.4
8 X 9	1.7	27.3	10 X 14	22.6
9 X 10	8.6	25.6	14 X 20	20.0
10 X 12	19.2	14.7	20 X 28	17.3
12 X 14	29.9	5.5	28 X 35	13.8
14 X 16	21.8	1.0	35 X 48	11.5
16 X 20	12.1	0.2	48 X 65	8.2
20 X 24	3.0	0.1	65 X 100	2.3
24 X 28	1.5	0	100 X 200	1.6
-28	1.9	0.2	-200	0.3
Particle Density, lb/cu ft	188.4	166.3		77.2
Calcining Weight Change, Wt %	+0.1			
Ultimate Analysis, Wt %(2)				
Moisture				0.55
C				77.27
H				3.32
S				2.25
Ash + SO_3				13.99
Elemental Analysis, Wt %(3)				
SiO_2	3.69	6.51		22.20
CaO	55.57	53.13		25.88
MgO	36.07	36.89		8.79
Na_2O	0.06	0.09		2.16
Fe_2O_3	2.04	0.86		3.60
Al_2O_3	2.17	1.91		9.49
P_2O_5	0.02	0.03		0.05
TiO_2	0.12	0.05		0.19
K_2O	0.01	0.21		0.23
SO_3	2.50	0.72		27.25
Sulfide	0.58			

(1) Run 17A dump material
(2) As received basis
(3) On calcined basis or total ash basis

Table 17-6. FEEDSTOCK COMPOSITES, RUN 17B

Run 17A

	Calcined Acceptor Return				
Date	2/25	2/27	2/28	3/1	3/2
Time	1630	1600	1600	0400	1600
Screen Size, Wt %					
Tyler Mesh					
+4	0	0	0	0	0
4 X 6	0	0	0	0	0.5
6 X 8	0.4	0.3	0.5	0.3	0.3
8 X 9	1.1	1.3	1.5	1.4	1.7
9 X 10	4.9	5.9	6.2	7.6	10.7
10 X 12	16.5	20.9	18.5	21.4	24.3
12 X 14	29.7	34.0	31.4	34.0	34.1
14 X 16	24.2	22.1	24.1	21.8	19.0
16 X 20	16.5	12.2	13.6	10.5	8.0
20 X 24	4.3	2.4	2.8	2.0	1.0
24 X 28	1.4	0.6	0.7	0.6	0.2
-28	1.0	0.3	0.8	0.3	0
Particle Density, lb/cu ft	199	-			
Calcining Weight Change, Wt %	-	-	-2.3	0.3	1.6
Elemental Analysis, Wt %(1)					
SiO_2			2.60	2.82	4.20
CaO			54.32	54.14	54.00
MgO			37.47	37.72	37.05
Na_2O			0.04	0.03	0.03
Fe_2O_3			1.68	1.60	2.00
Al_2O_3			1.27	1.29	1.89
P_2O_5			0.05	0.11	0.22
TiO_2			0.07	0.17	0.25
K_2O			0.02	0.01	0.02
Total S(2)			0.13	0.48	1.00
Sulfide(2)			-	0.45	0.87

(1) Calcined basis
(2) As received basis

Table 17-7. CIRCULATED ACCEPTOR, CALCINED ACCEPTOR RETURN, RUN 17A

Run 17A

	Recarbonated Acceptor Return				
Date	2/25	2/27	2/28	3/1	3/2
Time	1620	1600	2000	1200	1600
Screen Size, Wt %					
Tyler Mesh					
+4	0	0	0	0	0
4 X 6	0	0	0	0	0
6 X 8	0.6	0.4	0.2	0.4	0.3
8 X 9	1.4	1.0	0.8	1.6	1.3
9 X 10	5.8	4.4	5.4	7.3	6.8
10 X 12	18.0	14.7	16.0	19.5	17.9
12 X 14	29.5	29.8	29.1	30.0	30.0
14 X 16	22.8	23.7	24.1	21.8	22.2
16 X 20	15.5	17.2	16.0	13.2	13.2
20 X 24	3.9	4.7	4.4	3.2	3.4
24 X 28	1.4	2.0	2.0	1.5	2.2
-28	1.2	2.2	2.0	1.7	2.8
Particle Density, lb/cu ft	194	-	190.6	184	186
Calcining Weight Change, Wt %	-	-	-1.8	-0.8	-0.2
Activity			0.04	0.03	0.01
Elemental Analysis, Wt %(1)					
SiO_2			3.01	3.67	4.35
CaO			54.98	54.08	54.85
MgO			38.42	38.14	36.89
Na_2O			0.04	0.04	0.05
Fe_2O_3			1.69	1.77	2.00
Al_2O_3			1.21	1.52	1.90
P_2O_5			0.17	0.22	0.25
TiO_2			0.12	0.12	0.19
K_2O			0.01	0.01	0.02
Total S(2)			0.34	0.66	0.98
Sulfide(2)			-	0.48	0.95

(1) Calcined basis
(2) As received basis

Table 17-8. CIRCULATED ACCEPTOR, RECARBONATED ACCEPTOR RETURN, RUN 17A

Run 17B

	Calcined Acceptor Return						
Date	3/26	3/27	3/28	3/29	3/30	3/31	4/1
Time	1600	1600	1600	2200	1600	2200	1600
Screen Size, Wt %							
Tyler Mesh							
+4	0	0	0	0	0	0.3	0.4
4 X 6	0	0	0	0	0.1	0.7	0.6
6 X 8	0.3	0.3	0.1	0.3	5.9	10.8	11.9
8 X 9	1.4	0.9	0.9	1.6	7.5	17.5	20.3
9 X 10	8.4	9.3	7.0	10.8	18.0	22.2	22.9
10 X 12	21.0	24.1	20.8	23.2	25.5	20.1	18.4
12 X 14	32.6	35.0	33.8	32.2	26.4	16.2	14.4
14 X 16	21.5	20.1	22.6	18.9	12.2	6.8	6.1
16 X 20	11.2	8.5	11.0	9.1	4.8	3.0	2.9
20 X 24	2.4	1.4	2.4	2.3	1.1	1.1	1.0
24 X 28	0.7	0.4	0.8	0.9	0.3	0.7	0.5
-28	0.4	0.2	0.6	0.7	0.2	0.6	0.5
Calcining Weight Change, Wt %	-0.5	-	-	0.3	-	1.4	1.2
Elemental Analysis, Wt %(1)							
SiO_2	3.22			3.86		5.90	8.65
CaO	53.79			53.50		51.10	50.41
MgO	36.78			36.86		36.17	36.04
Na_2O	0.04			0.07		0.08	0.07
Fe_2O_3	1.70			2.37		1.57	1.51
Al_2O_3	1.73			1.78		2.65	0.49
P_2O_5	0.01			0.01		0.01	0.02
TiO_2	0.12			0.15		0.19	0.12
K_2O	0.01			0.01		0.05	0.03
SO_3	1.60			2.57		3.6	3.96
Total S(2)	0.64			1.03		1.44	1.58
Sulfide(2)	0.63			0.91			1.59

(1) Calcined basis
(2) As received basis

Table 17-9. CIRCULATED ACCEPTOR, CALCINED ACCEPTOR RETURN, RUN 17B

Date	3/26	3/27	3/28	3/29	3/30	3/31	4/1
Time	2000	1600	0200	0800	1600	2000	1200
Screen Size, Wt %							
Tyler Mesh							
+4	0	0	0.2	0	Tr	0.1	Tr
4 X 6	0	0	Tr	0	0.2	0.6	0.7
6 X 8	0.2	0.2	0.1	0.2	3.6	7.9	9.0
8 X 9	1.1	1.1	0.6	1.0	7.4	15.1	15.7
9 X 10	6.8	7.2	5.6	7.0	14.5	19.8	19.5
10 X 12	18.5	19.2	16.7	19.1	20.4	18.6	17.8
12 X 14	30.7	30.7	30.3	30.4	24.3	17.6	15.5
14 X 16	22.8	22.0	23.4	21.6	14.6	9.1	8.0
16 X 20	13.8	12.9	14.7	12.7	8.2	5.1	5.0
20 X 24	3.7	3.4	4.1	3.8	2.8	2.2	2.6
24 X 28	1.6	1.9	1.9	2.0	1.9	1.8	2.2
-28	0.9	1.4	2.4	2.1	2.1	2.4	4.2
Particle Density, lb/cu ft	180		184			130	126
Calcining Weight Change, Wt %	-2.2		-0.6			-4.9	-4.4
Activity	0.02		0.01			0.14	0.17
Elemental Analysis, Wt %(1)							
SiO_2	3.87		3.77			6.23	8.41
CaO	54.10		53.67			50.97	50.60
MgO	37.05		37.47			36.48	36.61
Na_2O	0.05		0.05			0.13	0.08
Fe_2O_3	1.75		2.06			1.59	1.47
Al_2O_3	1.82		0.49			2.23	0.48
P_2O_5	0.01		0.01			0.01	0.02
TiO_2	0.12		0.12			0.25	0.12
K_2O	0.02		0.01			0.07	0.05
SO_3	1.80		1.97			2.94	4.19
Total S(2)	0.72		.79			1.18	1.68
Sulfide(2)	0.66					-	1.49

(1) Calcined basis
(2) As received basis

Table 17-10. CIRCULATED ACCEPTOR, RECARBONATED ACCEPTOR RETURN, RUN 17B

Run 17A			
Date	2/28	3/1	3/2
Time	1800	0600	0600
Screen Size, Wt %			
Tyler Mesh			
+8	0	0.1	0
8 X 10	1.1	1.8	0
10 X 14	17.0	18.7	31.3
14 X 20	24.0	21.6	22.6
20 X 28	18.9	16.2	12.8
28 X 35	15.2	14.6	12.5
35 X 48	12.9	13.7	9.4
48 X 65	7.3	8.3	6.2
65 X 100	2.8	3.6	2.8
100 X 200	0.9	1.3	1.6
-200	Tr	0.1	.9

Table 17-11. GASIFIER CHAR TO REGENERATOR, RUN 17A

Run 17B

Date	3/26	3/27	3/28	3/29	3/30	3/31	4/2
Time	1800	2200	2200	2200	2200	1400	0240
Screen Size, Wt % Tyler Mesh							
+8	0	0	0	0	1.28	4.38	3.64
8 X 10	0	0	0	0	0	0	0
10 X 14	18.5	18.9	19.9	16.4	26.0	30.4	35.3
14 X 20	20.6	20.9	16.3	15.1	12.9	10.8	10.6
20 X 28	17.5	14.6	9.9	18.9	12.1	13.0	9.2
28 X 35	15.7	18.2	13.7	14.3	15.9	15.4	11.6
35 X 48	10.8	13.6	16.6	13.2	13.4	13.5	12.1
48 X 65	8.4	8.3	10.1	10.1	9.6	7.9	8.9
65 X 100	4.1	3.8	7.0	5.7	4.8	3.2	4.0
100 X 200	2.9	0.6	5.5	4.8	3.2	1.3	3.4
-200	1.4	1.1	1.0	1.4	0.9	Tr	1.3

Table 17-12. GASIFIER CHAR TO REGENERATOR, RUN 17B

Date	2/27	2/28	3/1
Time	2400	2400	2400
Screen Size, Wt %			
Tyler Mesh			
+60	1.0	0.3	2.1
60 X 100	10.6	8.6	13.2
100 X 325	40.0	36.9	31.4
-325	48.4	54.2	53.3
Ultimate Analysis, Wt %(1)			
Moisture	0	0	0
C	47.87	50.63	50.30
H	1.16	1.02	1.08
S	2.20	1.14	1.16
Ash + SO_3	41.35	40.62	38.21

(1) On a dried basis

Table 17-13. GASIFIER CHAR TO ORGANIC POND, RUN 17A

Run 17B						
Date	3/26	3/27	3/28	3/29	3/31	3/31
Time	0045	0000	2345	2400	0015	1330
Screen Size, Wt %						
Tyler Mesh						
+60	0	0.5	0.4	1.5	0.3	1.7
60 X 100	Tr	16.4	11.7	15.5	2.8	4.0
100 X 325	3.9	31.2	42.7	51.4	26.8	36.1
-325	96.2	51.9	45.2	31.7	70.2	58.3
Ultimate Analysis, Wt %(1)						
Moisture	0	0	0	0	0	0
C	61.28	56.29	45.10	51.30	44.50	47.96
H	1.14	1.48	0.94	0.89	0.65	0.90
S	3.06	2.50	0.96	1.38	1.03	0.86
Ash + SO_3	33.40	34.96	43.90	42.2	45.5	42.20

(1) On a dried basis

Table 17-14. GASIFIER CHAR TO ORGANIC POND, RUN 17B

Run 17A

Date	3/1	3/2
Time	0330	1200
Screen Size, Wt %		
Tyler Mesh		
+35	0.9	0.5
35 X 48	6.1	4.6
48 X 65	12.2	10.4
65 X 100	15.7	15.0
100 X 200	17.9	19.5
200 X 325	11.7	13.3
-325	35.5	36.7
Calcining Weight Change, Wt %(1)		
Elemental Analysis, Wt %(2)		
SiO_2	32.14	27.12
CaO	30.00	31.52
MgO	9.14	10.77
Na_2O	2.31	1.71
Fe_2O_3	3.04	3.31
Al_2O_3	11.76	11.61
P_2O_5	0.03	0.03
TiO_2	0.42	0.40
K_2O	0.38	0.24
SO_3	10.65	13.41

(1) Calcining in air
(2) Calcined basis

Table 17-15. ASH AND ATTRITED ACCEPTOR, RUN 17A

Date	3/27	3/28	3/29	3/30	3/31	4/1
Time	1300	0330	0315	0300	1800	0130
Screen Size, Wt % Tyler Mesh						
+35	1.3	1.3	0.4	1.3	0.8	0.3
35 X 48	3.2	4.8	2.6	5.1	2.3	2.1
48 X 65	6.2	13.1	5.8	10.9	5.8	6.8
65 X 100	10.0	11.4	10.8	17.4	11.2	13.9
100 X 200	17.6	17.2	23.0	21.5	19.3	21.6
200 X 325	14.2	14.5	16.6	12.6	12.5	13.2
-325	47.6	37.7	40.7	31.2	48.1	42.0
Calcining Weight Change, Wt %(1)	-5.6	-4.8		-5.1	+2.5	
Elemental Analysis, Wt %(2)						
SiO_2	28.49	27.13	24.04	26.29	17.3	18.6
CaO	32.34	33.27		31.46	39.75	
MgO	11.46	12.42		11.53	21.58	
Na_2O	1.98	1.64	1.40	2.12	1.27	0.56
Fe_2O_3	3.33	3.11		3.59	2.32	
Al_2O_3	11.69	10.23		13.93	8.99	
P_2O_5	0.02	0.03		0.02	0.02	
TiO_2	0.50	0.42		0.47	0.62	
K_2O	0.24	0.23		0.30	0.55	
SO_3	10.39	10.95		10.78	8.30	
Total S	4.16	4.38	4.73	4.31	3.32	3.84
Sulfide(3)	2.80	3.34		3.00	2.51	

(1) Calcining in air
(2) Calcined basis
(3) As received basis

Table 17-16. ASH AND ATTRITED ACCEPTOR, RUN 17B

Run 17B

Elemental Analysis, Wt %[1]	Agglomerated Acceptor Particles	Uniform Medium to Fine Grain Particles	Fuzed Conglomerate
SiO_2	7.65	54.48	24.30
CaO	51.40	13.29	32.74
MgO	31.86	15.51	22.83
Na_2O	0.13	0.33	0.31
Fe_2O_3	1.35	0.71	2.06
Al_2O_3	3.26	3.17	4.13
P_2O_5	0.02	0.02	0.02
TiO_2	0.14	0.09	0.20
K_2O	0.11	0.80	0.14
SO_3	3.81	13.59	14.61
Sulfide[2]	0.38	0.09	9.40
Calcining Weight Change, Wt %[3]	-0.80	-0.05	+12.04

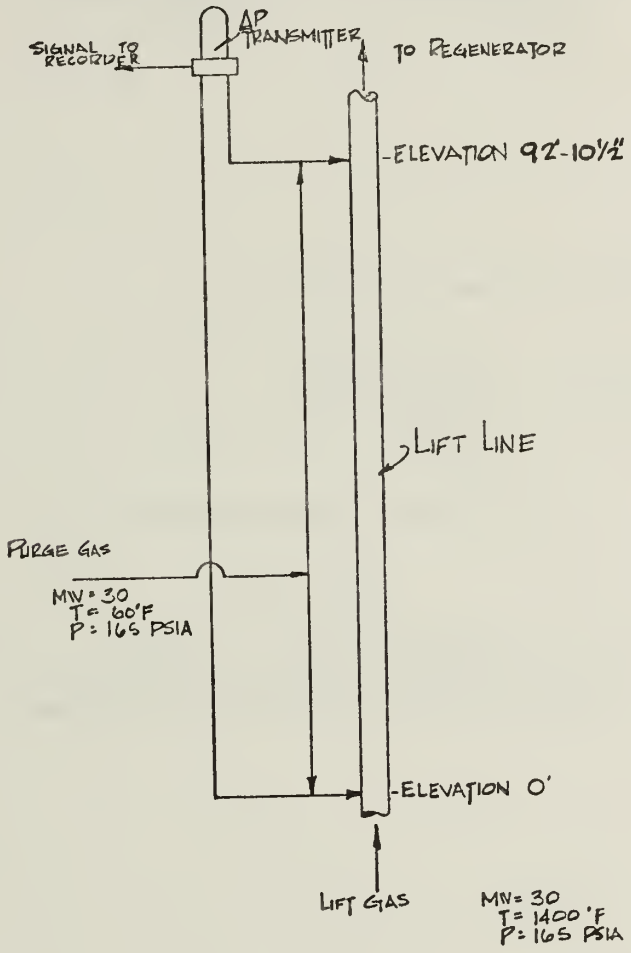
(1) Totally calcined basis
(2) As received basis
(3) Calcination in air

Table 17-17. REGENERATOR DEPOSITS, RUN 17B

Appendix 17A

CALCULATION OF DIFFERENTIAL PRESSURE MEASUREMENT CORRECTIONS

Problem: Figure below represents the differential pressure measuring system for the spent acceptor lift line. The correction which must be added to the measured readings to obtain the true differential may be determined by equation (1).



SPENT ACCEPTOR LIFT LINE DIFFERENTIAL PRESSURE MEASUREMENT CONFIGURATION

Therefore, based on the data shown in above Figure, the pressure correction is:

$$\Delta p = \frac{g}{g_c}\left[\frac{M_1}{T_1} - \frac{M_2}{T_2}\right]\frac{P\Delta L}{R} \qquad (1)$$

$T_1 = 460 + 60°F = 520°R$

$T_2 = 460 + 1400°F = 1860°R$

$$\Delta P = \frac{32.2 \frac{FT}{SEC}\ 2}{32.2 \frac{FT\text{-}LB_m}{LB_f\text{-}SEC^2}} * \left[\frac{30 \frac{LB_m}{LB_m - mole}}{520°R} - \frac{30 \frac{LB_m}{LB_m - mole}}{1860°R} \right] * \frac{165\ PSIA * 92.875\ FT}{10.73 \frac{PSIA - FT^3}{LB_m\ mole - °R}}$$

$$\Delta p = 59.3 \frac{LB_f}{FT^2}$$

converting to inches of water column (IN. WC)

$$\Delta p = 59.3 \frac{LB_f}{FT^2} \times \frac{FT^2}{144\ IN^2} \times \frac{27.7\ IN.\ WC}{\frac{LB_f}{IN^2}}$$

$\Delta p = 11.4$ IN. WC

This is a significant correction to apply, since the lift line normally operates with a 15-60 IN. WC differential pressure.

RUN 18

APRIL 19 TO APRIL 29, 1974

CO_2 ACCEPTOR PROCESS GASIFICATION

PILOT PLANT

RAPID CITY, SOUTH DAKOTA

1 SUMMARY

Run 18 started April 19, 1974, and concluded April 29, 1974. The objective of this run was to achieve long-term operation of the plant. Dead-burned dolomite was to be gradually replaced with active stone. This procedure was to continue until activity had lined out, at which time lignite was to be introduced into the gasifier char bed. Before this could be accomplished, a tube in the acceptor lift gas furnace, B-205 ruptured, terminating the run.

A series of problems in the char grinding area resulted in two days of minimum char feed to the gasifier. Thus, while acceptor activity did increase during the sixth day of fresh stone makeup, the data are not truly significant.

The run, however, did have several significant achievements. The ability to operate the plant during upsets while avoiding regenerator temperature runaways was demonstrated. The addition of steam to the boot did not interfere with spent acceptor withdrawal. Steam addition to the boot appears to reduce the rate of corrosion in the boot heaters.

2 TEST DATA

Run 18 data are presented tabularly at the end of this run report. The tables include:

		Page
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3 SIGNIFICANT EVENTS AND OBSERVATIONS

3.1 HISTORY

3.1.1 Purpose

The purpose of the Run 18 program was to achieve integrated operation of the plant. Dead-burned dolomite was the original charge for the regenerator. Active stone would replace this at 600 LBS/HR. After lining out the plant with active stone in the system, lignite would then be fed to the gasifier followed by another lining out period.

The procedure also called for the addition of steam to the gasifier boot. This addition occurred nine hours into the run and was performed smoothly. Approximately one-third of the boot flow was steam.

3.1.2 Accomplishments

During previous runs, refilling the fresh dolomite lockhopper caused periodic temperature excursions in the regenerator. To reduce these, the feed rate of fresh stone was gradually changed. This permitted a gradual reduction (or increase) of the heat load on the regenerator, and while permitting smoother operation, it did not entirely eliminate temperature fluctuations.

The addition of a large purge above the spent acceptor hopper permitted smooth withdrawal throughout the run. Even the addition of steam to the boot did not cause the plugs to form in either this line or the spent acceptor return line.

3.1.3 Termination Causes

Run 18 terminated when two outlet elbows ruptured in the acceptor lift gas furnace. Activation of the emergency shutdown system resulted in dumping the regenerator bed through the furnace when the slide valve below the regenerator failed to close. The recycle compressors were restarted to reduce the amount of dolomite that was being blown out through the heater. The sudden fluidization of the gasifier bed caused it to surge, destroying the differential pressure probe, the temperature probe, and the internal cyclone dip leg. The probes will not be replaced.

3.1.4 Mechanical Problems

Many problems were experienced during Run 18 with the operation of the char grinding and char drying systems. Most of these were

associated with a series of blower hose failures in the baghouse. This problem, however, appears to be rectified. Additional 100 area problems involved plugging of the Sweco screen used to size the char product and plugging of the fines line from the Sweco screen.

In addition to the char grinding problems, hot spots developed on several solid transfer lines. These were the result of either end cone failure or settling of insulation in the annulus between the two pipes. These hot spots never became a serious problem.

The gasifier quench system began to plug due to high solids loading. Revisions in the quench system and the gasifier internal cyclone are planned to alleviate this problem.

3.1.5 Process Problems

During Run 18, few process problems were evident. Dolomite circulation stopped several times. However, each time circulation was reestablished with a minimum of problems. While the reasons for these stoppages is unknown, the unstable operation of the plant with minimum char feed to the gasifier may have contributed to this problem. In addition, the outlet line from the regenerator has sagged causing a bend in the line. This reduction in flow area may have caused some of the circulation problems. This line, which extended approximately 18 inches into the regenerator has been shortened.

3.2 RUN 18 CHRONOLOGY

Date	Time	Description
4/19	1515	Pressuring up "A" and "B" headers. System purges set.
"	1620	J-309, char lift compressor, started with flow to the system.
"	1750	System at 150 PSIG. Setting up for static pressure test. Test completed.
"	1945	Recycle compressors started.
"	1955	Heaters lit.
4/20	0030	Gasifier and regenerator steam drums in service.
"	0230	Zinc oxide unit in service.
"	0730	Dolomite started to gasifier.
"	0930	Dolomite feed from F-206 started to the regenerator.
"	1110	Check dump to F-213, purged dolomite lockhopper.
"	1607-1720	Not feeding from F-206. Dumped F-213. Refed dumped dolomite to gasifier via "A" lignite lockhopper.
"	1700	Checked recarbonated acceptor transfer, OK.
"	1910	Regenerator full. Started acceptor circulation.
"	1950	Started gas flow tests on lift line.
"	2300	Hot spot noted on calcined acceptor return line on seventh floor.

Date	Time	Description
4/20	2400	Started solids circulation tests.
4/21	0730	Finished solids circulation tests.
"	0850	Char feed started to gasifier.
"	1040	Air started to gasifier.
"	1640	Char bed at 25 feet. Char feeder put on automatic.
"	2220	Transfer char check to regenerator, OK.
4/22	0330	Checked recarbonated acceptor return, OK.
"	0500	Checked dump to F-213, OK.
"	0600	Checked calcined acceptor return, OK.
"	0700	Cooling B-203 and B-204 heaters in preparation for regenerator char combustion.
"	0745	Started acceptor circulation.
"	0810	Air started to regenerator.
"	0840	Withdrawal to F-213 started.
"	0900	Started char feed to regenerator.
		NOTE: Char feed to regenerator erratic for next several hours. Dolomite circulation also erratic.
"	2100	Char feed established.
"	2125	Dolomite circulating but not up to expected rate.
4/23	0115	Regenerator at 1800°F.
"	0250	Grinding to preheater.
		NOTE: Continue to experience problems with acceptor circulation.
"	0545	Circulation of acceptor seems established.
"	0800	J-207, regenerator recycle compressors, taken off line.
"	0935	Steam to gasifier boot.
"	1330	Acceptor circulation at 11,000 LBS/HR.
4/24	0030	Hot spot noted on gasifier side flow line (CO-203 first floor), 650°F temperature stick tacky.
"	0250	Char grind to preheater.
"	0545	Slight adjustment in acceptor transfer made. Unit reacted favorably. All instruments indicated correctly.
"	0600	Fiber drum and plastic liner test on ground char storage complete. All OK.
"	1210	Acceptor (dead-burned dolomite) makeup rate at 2 RPM on L-204 (600 LBS/HR).
"	1535	F-206 recharged with fresh 6 x 9 dolomite and feeder on.
"	2030	Started having problems with acceptor circulation.
"	2345	Circulation seems to be coming back.
4/25	0304	Char grinding to preheater.
		NOTE: Circulation of acceptor less than expected for valve position of TCV2030.
		NOTE: Maintaining conditions while adding fresh 6 X 9 dolomite.

Date	Time	Description
4/25	0745	Recycle flue gas through the air distributor ring in the regenerator removed.
"	0950	Air taken out of gasifer but had to be put back in to hold temperature (very small amount).
"	1430	Started to lose acceptor circulation. Blast of N_2 to clear calcined acceptor standleg, CD-206, caused loss of seal and blow back. Considerable solids carryover to flue gas quench system.
"	1510	Circulation restored. NOTE: Outlet piping of flue gas quench tower plugged. Temporary drains installed. NOTE: Continuing to decrease air to gasifier as temperature permits. NOTE: B-203 heater kicked out for no known reason.
4/26	0040	Char feed rate increased.
"	0050	Removed air from gasifier. NOTE: Some acceptor circulation problems.
"	0200	Line differential pressures indicate CD-206 is not running full at 13 PSIG loading on TCV-2030.
"	0215	Flow rate in acceptor lift line was reduced to maintain 2.6 FT/SEC velocity in regenerator.
"	0230	Losing seal and acceptor circulation in CD-206. Stroking TCV-2030 to improve circulation.
"	0310	Seal recovered and acceptor circulation established. Gasifier temperature dropped to 1430°F.
"	0400	Started grinding char to preheater.
"	0620	Acceptor circulation problems again. Stroking TCV-2030. Line differential pressures do not indicate trouble as before. Continuing problems: 1. Gasifier compressor suction knockout pot high level. 2. Acceptor circulation problems. 3. Regenerator quench tower filling.
"	0700	Air put back into gasifier. The temperature dropped to 1435°F. NOTE: The gasifier quench separator was flooded to wash out plug in spool between quench tower and quench separator. This seemed to get quench problems cleared (gasifier knockout pot high level). Temporary line put in regenerator quench drain system to enable the system to be put on level control. Acceptor circulation was recovered after rest of system settled down.
"	0900	Problems with transfer of recarbonated acceptor through LCV-2003, precipitating transition zone problems in gasifier. Cleared.
"	1105	Gasifier quench system pluggage. Cleared by flooding out plug.

Date	Time	Description
4/26	1215	Reoccurrence of quench plug, cleared. NOTE: Above plugs and accompanying pressure fluctuations affects the acceptor circulation. After each unplugging operation, acceptor circulation must be adjusted.
"	1400	Gasifier quench system plugged. Cleared by flushing.
"	1445	Repeat of above.
"	1800	Air out of gasifier.
"	2230	Experienced a holdup of acceptor in the gasifier transition zone creating problems with transfer of acceptor from gasifier to the regenerator.
"	2250	Transition zone and spent dolomite transfer lining out. NOTE: High pressure drop in baghouse in 100 area has stopped grinding. Maintenance called out to open, inspect, and repair. Fines bin cleared. NOTE: Broken blower ring hose found in baghouse. Maintenance replaced both 4-inch blower ring hoses.
"	2330	Slight gasifier bed shakeup caused by level controller operation. LIC-2003 set point was lowered from 30 to 20.
4/27	0205	Air removed from gasifier.
"	0330	Started char grind in 100 area. Ran well for 10 minutes before baghouse dP became excessive.
"	0600	Baghouse inspection indicates another ruptured hose.
"	0620	Shakeup in circulation.
"	0745	Good circulation seems to be reestablished.
"	0945	Air into gasifier.
"	1100	More circulation problems. NOTE: Char supply running low. The char grinding area down due to baghouse problems.
"	1500	Preparing unit for "hold" condition pending the supply of more char from grinding operation. 1. Stopped acceptor feed from F-206. 2. Dumped F-213. 3. Excess flue gas out of preheater. 4. Cooling regenerator to 1800°F. 5. Cooling gasifier to 1400°F. 6. HPC system put in service. 7. One J-207 compressor put in service.
"	1600	All air out of gasifier. Natural gas put into regenerator.
"	1800	Maintenance given 100 area.
"	2230	Acceptor feed to regenerator at 3/4 RPM.

Date	Time	Description
4/28		NOTE: Bags being changed out in baghouse. Blow rings being cleaned.
"	0400	All rings cleaned and replaced. Carriage test run. NOTE: Unit on "hold" condition pending correction of difficulties in the char feedstock preparation area. 100 area progress as follows:
"	0800	100 area problems: Grinding area heating up.
"	0900	Grinding to tote bin.
"	1005	Hole detected in Sweco screen, grinding shut down.
"	1130	Sweco repaired, grinding initiated.
"	1245	Baghouse dP increase.
"	1300	Grinding shut down. Cooling baghouse.
"	1810	Hose in baghouse repaired. Grinding started.
"	1920	Grinding char.
"	2045	Shutting grinding down, sheared pin on Redler conveyor. Clearing lines.
"	2300	Plugged surge bin cleared through feeder. NOTE: FR-2029 (flue gas vent) giving erroneous reading.
4/29	0115	Grinding to preheater
"	0250	Plug in fines line from Sweco. Grinding shut down.
"	0355	Started grinding to preheater.
"	0420	Fines line plugged, unplugged.
"	0425	Product line from Sweco plugged, unplugged.
"	0505	Grinding to preheater.
"	1200	Evidence of recarbonated acceptor line plugging. NOTE: During above problems, regenerator air heater B-205 was found to have a ruptured tube.
"	1300	Activated ESD-2. Plant shut down.

4 RESULTS AND DISCUSSIONS

Run 18 demonstrated the ability to maintain the plant on stand-by condition. In addition, process upsets, loss of circulation, and methane combustion in the regenerator were all handled effectively. These problems, which had been serious in the past, were handled routinely.

Preliminary dolomite circulation tests were again performed during Run 18. The solids circulation rate with respect to lift line dP, as indicated by dPT-2022, was essentially the same as in previous runs.

Data obtained during Run 18 are presented in Tables 18-1 through 18-9. In Tables 18-1 and 18-2, the plant operating conditions are summarized. Physical and chemical property data of the process solids are presented in Tables 18-3 through 18-9.

The vessel deposits found in Run 18 consisted primarily of acceptor. In the regenerator, a deposit containing a large percentage of active acceptor was formed above the distributor ring. This deposit was loose in nature and high in silica. A second deposit consisted primarily of dead-burned dolomite. This was hard and formed in the cone below the ring increasing the shape of this cone. The gasifier deposit was found in the boot section and consisted of agglomerated dead-burned dolomite.

5 FUTURE PLANS

The Run 19 operating procedure will be basically the same as that for Run 18. However, lignite will be introduced early in the run immediately after circulation has lined out. The dead-burned dolomite inventory will then be replaced, and the system lined out.

Date	4/22	4/22	4/22	4/23	4/23	4/23	4/24	4/24	4/24	4/25	4/25	4/25
Time	0900	1500	2300	0700	1500	2300	0700	1500	2300	0700	1430	2300
Jacket Steam Make, lb/hr	0	0	0	0	0	0	0	0	0	0	0	0
Solids												
Feedstock	← Husky Char →											
Feed Rate, lb/hr	0	0	0	600	1,200	1,200	1,200	1,300	1,300	1,000	1,240	1,460
Heating Value (DuLong), Btu/lb	← 12,061 →											
Dump Acceptor, lb/hr	← 310 →					300	460	460	460	280	280	290
Gas Flow(1)												
Boot (Recycle), SCFH	21,600	22,500	23,300	23,900	20,500	17,200	17,100	17,100	17,200	18,600	18,000	17,860
Boot (Steam), SCFH	0	0	0	0	3,500	7,300	7,160	6,800	7,000	6,500	7,000	6,900
Steam to Side, SCFH	27,100	25,500	27,200	27,000	36,200	35,600	36,100	38,600	38,400	41,000	49,100	46,900
Air to Side, SCFH	21,100	19,700	19,600	17,400	10,000	12,200	12,400	11,700	12,300	8,100	2,000	5,300
Purges												
Recycle, SCFH	4,650	4,720	4,670	4,770	4,890	4,900	4,940	4,950	5,000	5,260	5,400	5,160
Inert, SCFH	← 400 →											
Total Flow In, SCFH	74,850	72,800	75,200	73,500	75,500	77,600	78,100	79,550	80,300	79,860	81,900	82,500
Vent Rate, SCFH	31,400	31,900	31,300	31,400	26,300	29,500	29,500	33,300	31,700	26,000	20,000	27,200
Bed Conditions												
Boot Velocity, ft/sec	1.19	1.18	1.23	1.30	1.28	1.30	1.30	1.28	1.30	1.35	1.32	1.31
Char Bed Velocity Inlet, ft/sec	0.77	0.76	0.76	0.77	0.76	0.79	0.79	0.80	.81	.81	.81	.83
Boot Density, lb/ft^3(2)	102	108	97.5	93	86	76	87	84	81	78	75	74
Char Bed Density, lb/ft^3(2)	35	31.5	35.0	38	43	41	40	40	40	41.5	42	42
Boot Temperature, °F	1490	1470	1473	1510	1495	1500	1520	1515	1525	1535	1495	1515
Char Bed Temperature, °F	1523	1510	1482	1536	1501	1510	1515	1511	1523	1531	1505	1516
Overhead Gas Composition, Mol %(3)												
O_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	16.7	15.3	14.4	17.3	15.8	16.0	15.6	15.2	15.5	14.9	8.0	12.8
CO_2	14.4	14.0	15.3	13.2	15.2	15.1	14.2	14.6	12.3	11.7	11.8	11.1
N_2	42.9	42.9	42.2	39.0	25.2	25.2	27.6	26.2	25.4	20.0	28.3	17.8
H_2	23.8	25.2	24.7	27.9	39.1	39.3	38.2	39.7	41.6	47.7	44.9	51.7
CH_4	2.2	2.6	3.2	2.6	4.7	4.3	4.4	4.3	4.4	5.6	6.9	6.6
H_2O Mol Fraction	?	14.7	43.5	16.9	23.2	27.4	25.9	27.0	27.5	26.0	28.80	26.5

(1) Determined by orifice flow meter measurements
(2) Density indicated by pressure tap readings
(3) Moisture free

Table 18-1. GASIFIER DATA (Sheet 1 of 2)

Date	4/26	4/26	4/26	4/27	4/27	4/27	4/28	4/28	4/28	4/29	4/29
Time	1100	1900	2300	0700	1445	2300	0700	1500	2300	0700	1100
Jacket Steam Make, lb/hr	0	0	0	0	0	0	0	0	0	0	0
Solids											
Feedstock	←					Husky Char	→				
Feed Rate, lb/hr	1,270	1,290	1,320	1,470	1,460	400	360	630	435	331	728
Heating Value (DuLong), Btu/lb	←					12,061	→				
Dump Acceptor, lb/hr	320	250	280	420	400	50	50	50	0	0	0
Gas Flow(1)											
Boot (Recycle), SCFH	17,700	19,700	15,200	15,000	16,200	19,200	21,800	22,860	17,400	18,600	20,300
Boot (Steam), SCFH	6,700	7,400	8,770	8,600	7,680	8,030	7,170	7,150	8,690	8,230	7,350
Steam to Side, SCFH	45,600	45,700	44,700	45,800	38,900	29,900	31,250	30,200	29,700	28,600	30,300
Air to Side, SCFH	2,400	0	0	200	12,100	0	0	0	0	0	0
Purges											
Recycle, SCFH	5,600	5,860	5,860	5,400	5,250	6,080	6,990	6,980	6,370	6,670	6,320
Inert, SCFH	←					400	→				
Total Flow In, SCFH	78,400	79,000	74,900	75,400	80,530	63,600	67,600	67,600	62,600	62,500	64,670
Vent Rate, SCFH	25,100	16,600	16,360	20,000	28,800	0	0	1,160	0	0	4,000
Bed Conditions											
Boot Velocity, ft/sec	1.30	1.41	1.24	1.24	1.27	1.36	1.45	1.48	1.33	1.35	1.40
Char Bed Velocity Inlet, ft/sec	.79	.77	.73	.74	.81	.60	.62	.62	.59	.60	.60
Boot Density, lb/ft^3(2)	71	69	69	68	65	69	72	81	81	80	78
Char Bed Density, lb/ft^3(2)	41.5	43	42	42	40	36	35	34	33	33	34
Boot Temperature, °F	1528	1490	1472	1487	1507	1410	1435	1415	1435	1430	1440
Char Bed Temperature, °F	1539	1500	1479	1494	1504	1411	1446	1407	1430	1428	1421
Overhead Gas Composition, Mol %(3)											
O_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	12.7	11.7	10.0	13.6	12.5	7.0	4.5	4.4	4.5	4.3	5.9
CO_2	10.0	9.5	9.5	11.2	11.5	8.0	4.7	5.1	6.4	5.4	6.5
N_2	17.4	7.9	11.5	15.7	27.0	15.9	13.7	7.8	21.6	16.2	17.8
H_2	54.7	61.6	59.6	51.3	43.6	59.3	69.0	70.4	59.7	64.8	60.5
CH_4	5.1	9.2	9.4	8.2	5.3	9.8	8.1	12.3	7.8	9.8	9.2
H_2O Mol Fraction	26.1	25.4	29.7	33.6	29.6	32.2	26.4	37.3	38.7	40.0	35.9

(1) Determined by orifice flow meter measurements
(2) Density indicated by pressure tap readings
(3) Moisture free

Table 18-1. GASIFIER DATA (Sheet 2 of 2)

Data	4/22	4/22	4/22	4/23	4/23	4/23	4/24	4/24	4/24	4/25	4/25	4/25
Time	0900	1500	2300	0700	1500	2300	0700	1500	2300	0700	1430	2300
Jacket Steam Make, lb/hr	250	250	275	310	340	350	330	380	370	350	350	350
Solids												
Acceptor Feedstock	← Dead-Burned →								← 6 X 9 Dolomite →			
Acceptor Makeup, lb/hr	150	150	150	150	300	300	300	300	600	600	300	500
Acceptor Circulation, lb/hr(1)	2,900	1,740	5,500	6,670	11,000	10,440	11,600	10,150	9,280	11,890	11,600	10,730
Ash & Attrited Acceptor, lb/hr(2)	0	0	0	44	125	100	85	110	137	219	670	144
Gas Flows(3)												
Acceptor Lift, SCFH	58,600	58,000	58,600	57,500	57,300	57,900	58,900	57,400	57,000	56,900	57,500	56,900
Char Lift, SCFH	7,370	7,140	7,540	7,710	7,490	7,500	7,460	7,490	6,950	7,590	7,580	7,540
Air Line												
Recycle, SCFH	79,800	49,100	52,900	50,200	27,900	20,000	17,500	17,400	16,300	5,240	0	0
Air, SCFH	22,400	40,000	47,300	53,200	56,600	57,800	57,000	57,000	60,500	63,600	67,500	67,600
Purges												
Recycle, SCFH	552	552	535	531	526	527	527	528	515	511	509	508
Inert, SCFH	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530
Nitrogen, SCFH	850	850	850	850	850	850	850	850	850	850	850	850
Total Flow In, SCFH	171,100	157,200	169,300	171,500	152,200	146,100	143,800	142,200	143,600	136,200	135,500	134,900
Vent Rate, SCFH	21,000	37,200	49,660	56,830	61,140	65,240	58,800	63,200	68,680	72,800	79,100	84,040
Bed Conditions												
Gas Velocity Inert, ft/sec	2.20	2.57	2.71	3.14	2.78	2.66	2.64	2.59	2.62	2.48	2.49	2.47
Bed Density, lb/ft^3(4)	70-83	64-77	60-81	59-76	57-73	57-71	57-71	55-69	51-66	51-65	49-64	45-60
Average Bed Temperature, °F	1154	1597	1552	1840	1837	1835	1850	1835	1835	1835	1860	1846
Overhead Gas Analysis, Mol %												
O	0	0	0	0	0	0	0	0	0	0	0	0
CO	4.2	.8	7.2	1.7	2.6	3.9	1.4	4.1	2.9	0.7	2.2	5.3
CO_2	12.4	14.0	14.8	18.4	19.2	18.4	19.6	18.0	22.0	24.0	24.0	22.8
N_2	83.4	85.2	78.0	79.9	78.2	77.7	79.0	77.9	75.1	75.3	73.8	71.9

(1) Determined by lift line pressure drop measurements
(2) Determined by weigh scale measurements
(3) Determined by orifice flow meter measurements
(4) Density indicated by pressure tap readings

Table 18-2. REGENERATOR DATA (Sheet 1 of 2)

Date	4/26	4/26	4/26	4/27	4/27	4/27	4/28	4/28	4/28	4/29	4/29
Time	1100	1900	2300	0700	1445	2300	0700	1500	2300	0700	1100
Jacket Steam Make, lb/hr	330	340	340	340	340	330	340	360	350	340	350
Solids											
Acceptor Feedstock	← 6 X 9 Dolomite →										
Acceptor Makeup, lb/hr	600	600	600	600	600	110	110	100	110	110	110
Acceptor Circulation, lb/hr(1)	13,050	12,180	8,990	9,280	8,120	4,640	5,510	5,510	6,090	8,120	8,990
Ash & Attrited Acceptor, lb/hr(2)	100	140	130	275	60	54	46	46	20	0	0
Gas Flows(3)											
Acceptor Lift, SCFH	53,400	53,300	53,900	54,800	53,500	54,900	54,900	55,900	55,800	55,000	55,300
Char Lift, SCFH	7,460	7,270	7,340	7,470	7,600	6,800	6,930	6,940	6,930	6,930	7,020
Air Line											
Recycle, SCFH	0	0	0	0	0	24,200	23,900	29,000	28,900	28,900	28,400
Air, SCFH	65,400	69,300	65,900	65,800	57,800	52,800	52,300	49,900	50,700	50,100	52,600
Purges											
Recycle, SCFH	506	507	507	506	500	566	566	567	567	567	565
Inert, SCFH	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530	1,530
Nitrogen, SCFH	850	850	850	850	850	850	850	850	850	850	850
Total Flow In, SCFH	129,100	132,800	130,000	131,000	121,800	141,600	141,000	144,700	145,300	143,900	146,300
Vent Rate SCFH	75 300	78,000	78,580	77,710	65,400	36,800	37,120	14,240	0	17,870	18,360
Bed Conditions											
Gas Velocity Inert, ft/sec	2.34	2.44	2.39	2.40	2.22	2.54	2.50	2.57	2.62	2.60	2.65
Bed Density, lb/ft^3(4)	44-67	40-54	42-57	42-57	40-53	43-56	47-60	47-61	46-58	45-58	48-59
Average Bed Temperature, °F	1829	1858	1861	1854	1848	1800	1778	1782	1815	1816	1819
Overhead Gas Analysis, Mol %											
O_2	0	0	0	0	0	0	0	0	0	0	0
CO	1.7	2.6	0.9	4.7	2.2	0.3	.4	1.4	2.4	2.0	2.0
CO_2	25.2	24.4	25.2	23.6	24.8	11.2	11.0	10.4	10.0	10.0	12.4
N_2	73.1	73.0	73.9	71.7	73.0	88.5	88.6	88.2	87.6	88.0	85.6

(1) Determined by lift line pressure drop measurements
(2) Determined by weigh scale measurements
(3) Determined by orifice flow meter measurements
(4) Density indicated by pressure tap readings

Table 18-2. REGENERATOR DATA (Sheet 2 of 2)

	Dolomite		Char	
Screen Size, Wt % Tyler Mesh	Dead-Burned	Typical 6 X 9	Screen Size, Wt % Tyler Mesh	
+4	0	0	+6	0
4 X 6	0	Tr	6 X 8	0
6 X 8	0.2	30.8	8 X 10	0.5
8 X 9	1.3	25.4	10 X 14	4.8
9 X 10	6.1	23.5	14 X 20	8.4
10 X 12	17.7	12.7	20 X 28	12.4
12 X 14	32.2	5.2	28 X 35	14.4
14 X 16	24.2	1.3	35 X 48	18.0
16 X 20	14.5	0.3	48 X 65	14.6
20 X 24	2.6	0.2	65 X 100	8.8
24 X 28	0.8	0.1	100 X 200	10.9
-28	0.4	0.6	-200	7.3
Particle Density, lb/cu ft	201	164		76.7
Calcining Weight Change, Wt %	-1.2	-45.7		
Ultimate Analysis, Wt %				
Moisture				0.20
C				76.58
H				2.51
N				-
S				1.85
Ash + SO_3				13.96
Elemental Analysis, Wt%(1)				
SiO_2	3.06	9.41		20.99
CaO	55.60	49.47		24.75
MgO	34.44	35.53		7.67
Na_2O	0.06	0.09		1.81
Fe_2O_3	1.84	1.19		3.49
Al_2O_3	1.93	2.74		9.54
P_2O_5	0.02	0.01		0.03
TiO_2	0.20	0.08		0.45
K_2O	0.02	0.08		0.24
SO_3	2.01	0.67		30.71

(1) On calcined basis or total ash basis

Table 18-3. FEEDSTOCK COMPOSITES

Date	4/22	4/23	4/24	4/25	4/26	4/27	4/28	4/29
Time	0945	1000	0940	1000	1000	1000	1045	1000
Screen Size, Wt %								
Tyler Mesh								
+4	0	0	0	0	0	0	0	0.1
4 X 6	0	0	0	0.6	0.3	0.1	0.1	0.2
6 X 8	0	0.2	0.5	3.3	6.6	8.8	6.2	6.5
8 X 9	Tr	0.7	2.5	6.9	14.5	18.5	15.6	16.8
9 X 10	5.4	11.2	11.7	14.0	19.5	22.7	19.3	20.2
10 X 12	20.0	27.3	24.2	21.4	20.4	17.6	18.6	19.0
12 X 14	27.1	29.1	30.2	23.4	18.7	14.4	17.4	16.2
14 X 16	19.0	16.8	17.1	13.7	9.7	7.4	8.8	8.4
16 X 20	18.7	11.4	10.6	9.0	5.9	4.5	5.7	5.0
20 X 24	7.3	2.6	2.5	2.5	1.8	2.0	2.2	2.4
24 X 28	2.0	0.6	0.6	1.1	1.0	1.5	1.6	1.5
-28	0.5	Tr	0.1	4.2	1.4	2.5	4.3	3.6
Particle Density, lb/cu ft			177.9			128.8		
Calcining Weight Change, Wt %	-0.5	+0.07	+0.6	-0.36	+0.34	+0.5	-3.05	-2.2
Elemental Analysis, Wt %								
SiO_2	0.40	1.75	3.51	8.13	6.39	8.64	3.80	6.64
CaO			54.96			51.12		51.99
MgO			35.66			33.95		34.75
Na_2O	0.01	0.03	0.01	0.07	0.08	0.06	0.07	0.06
Fe_2O_3			1.68			1.13		0.82
Al_2O_3			1.77			2.55		1.89
P_2O_5			0.01			0.02		0.02
TiO_2			0.08			0.10		0.10
K_2O			0.03			0.06		0.23
SO_3	0	0.50	1.15	1.03	2.54	1.75	0.78	0.83
Sulfide						0.69		0.39

Table 18-4. CIRCULATED ACCEPTOR, CALCINED ACCEPTOR RETURN

Date	4/22	4/23	4/24	4/25	4/26	4/27	4/28	4/29
Time	1600	0800	1200	0800	0800	0800	0800	0800
Screen Size, Wt % Tyler Mesh								
+4	0	0	0	Tr	0	0	0	0
4 X 6	0	0	0	Tr	Tr	Tr	0	0
6 X 8	0	0.1	1.1	2.8	6.1	7.7	6.6	4.3
8 X 9	0	0.4	4.0	5.4	14.4	16.9	17.7	13.2
9 X 10	5.2	6.9	11.8	11.7	18.2	19.0	22.0	19.4
10 X 12	19.2	21.9	23.4	18.5	18.7	17.1	18.3	18.3
12 X 14	25.8	26.7	20.4	23.2	18.7	15.3	15.5	17.7
14 X 16	19.2	18.6	13.2	16.0	10.8	6.0	7.5	10.1
16 X 20	19.7	17.7	16.1	13.1	7.6	6.9	5.8	6.8
20 X 24	8.0	5.7	5.2	4.3	2.6	3.5	2.7	3.6
24 X 28	2.2	1.5	1.9	2.1	1.8	3.1	2.2	3.2
-28	0.7	0.5	2.9	3.1	1.8	4.5	1.7	3.3
Particle Density, lb/cu ft	201	183.6	174.6	167.3	143.5	133.0	125.8	134.1
Calcining Weight Change, Wt %		-1.60	-2.6	-4.94	-5.10	-7.04	-6.48	-9.7
Activity	0.03	0.014	0.065	0.109	0.18	0.19	0.24	0.23
Elemental Analysis, Wt %								
SiO_2	8.31	1.90	3.54	7.25	6.29	7.99	8.53	8.91
CaO			53.20			49.90		50.31
MgO			35.67			34.66		33.94
Na_2O	0.84	0.03	0.01	0.05	0.08	0.06	0.10	0.10
Fe_2O_3			1.66			1.11		1.28
Al_2O_3			1.81			2.54		2.78
P_2O_5			0.01			0.02		0.01
TiO_2			0.11			0.13		0.09
K_2O			0.01			0.06		0.10
SO_3	5.43	0.53	1.30	1.03	1.89	2.13	0.39	0.63
Sulfide			0.56					0.21

Table 18-5. CIRCULATED ACCEPTOR, RECARBONATED ACCEPTOR RETURN

Date	4/24	4/27	4/29
Time	1400	1000	0600
Screen Size, Wt %			
Tyler Mesh			
+8	0	0	0.2
8 X 10	0	0	Tr
10 X 14	Tr	0.2	0.2
14 X 20	3.5	0.8	3.9
20 X 28	22.6	15.5	12.3
28 X 35	39.5	33.5	19.3
35 X 48	9.3	27.0	23.9
48 X 65	18.2	14.6	20.2
65 X 100	6.3	4.8	9.3
100 X 200	0.3	3.2	7.4
-200	Tr	0.4	3.7

Table 18-6. GASIFIER CHAR TO REGENERATOR

Date	4/23	4/24	4/25	4/26	4/27	4/28	4/29
Time	0400	0400	0400	0400	0400	0400	0400
Screen Size, Wt %							
Tyler Mesh							
+60	19.1	2.6			3.1		1.5
60 X 100	24.1	18.9			19.1		24.7
100 X 325	22.3	27.1			19.3		46.5
-325	34.5	51.3			58.5		27.3
Ultimate Analysis, Wt %							
Moisture	0	0	0	0	0	0	0
C	54.88	52.06	51.47		46.86	51.64	59.38
H	1.53	1.02	1.92		1.04	0.97	1.09
S	0.90	1.17	0.98		0.49	0.51	0.82
Ash + SO_3	37.50	39.43	38.25	39.44	40.00	38.08	32.66
Elemental Analysis, Wt %							
SiO_2	22.95	25.49	23.97	20.84	24.93	22.31	25.11
CaO		34.66			33.49		32.94
MgO		4.23			6.57		5.23
Na_2O	1.39	1.38	1.33	1.06	9.60	0.45	1.62
Fe_2O_3		13.94			11.63		11.99
Al_2O_3		11.52			10.56		11.78
P_2O_5		0.03			0.02		0.06
TiO_2		0.74			0.82		0.72
K_2O		0.18			0.27		0.42
SO_3	10.60	7.40	6.27	6.03	3.11	5.87	6.32

Table 18-7. GASIFIER CHAR TO ORGANIC POND

Date	4/24	4/25	4/26	4/27	4/28	4/29
Time	0915	0400	0300	0900	0420	0415
Screen Size, Wt %						
Tyler Mesh						
+35	4.2	0.8	0.2	0.5	0.3	1.1
35 X 48	2.3	1.8	1.7	1.8	0.7	2.7
48 X 65	5.2	4.7	5.7	5.1	2.9	8.8
65 X 100	9.3	8.9	11.0	9.3	8.2	16.8
100 X 200	21.9	18.3	21.6	19.1	21.4	22.9
200 X 325	15.6	14.9	15.3	15.0	15.3	12.1
-325	41.3	50.5	44.5	49.2	51.2	35.6
Calcining Weight Change, Wt %	-0.4			+1.9		-10.0
Elemental Analysis, Wt %						
SiO_2	20.86		17.20	19.55	13.10	23.41
CaO	40.49			37.91		35.63
MgO	14.40			22.06		21.25
Na_2O	1.27		1.13	1.04	0.46	1.56
Fe_2O_3	2.83			1.60		2.49
Al_2O_3	10.31			7.14		7.67
P_2O_5	0.04			0.03		0.20
TiO_2	0.42			0.37		0.31
K_2O	0.22			0.48		0.61
SO_3	10.77		9.61	9.93	6.13	7.70

Table 18-8. ASH AND ATTRITED ACCEPTOR

	Regenerator		Gasifier
	Active Acceptor	Dead-Burn Acceptor	
Elemental Analysis, Wt %[1]			
SiO_2	21.87	2.02	8.20
CaO	37.55	52.44	52.95
MgO	26.29	32.80	35.60
Na_2O	0.57	0.99	0.14
Fe_2O_3	1.84	1.13	1.53
Al_2O_3	0.70	0.53	0.71
P_2O_5	0.02	0.02	0.01
TiO_2	0.21	0.93	0.15
K_2O	0.16	0.33	0.42
SO_3	10.87	9.80	0.40
Sulfide[2]	0.09	4.62	0.16
Calcining Weight Change, Wt %	-0.44	+4.31	-12.66

(1) Totally calcined basis
(2) As received basis

Table 18-9. VESSEL DEPOSITS

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